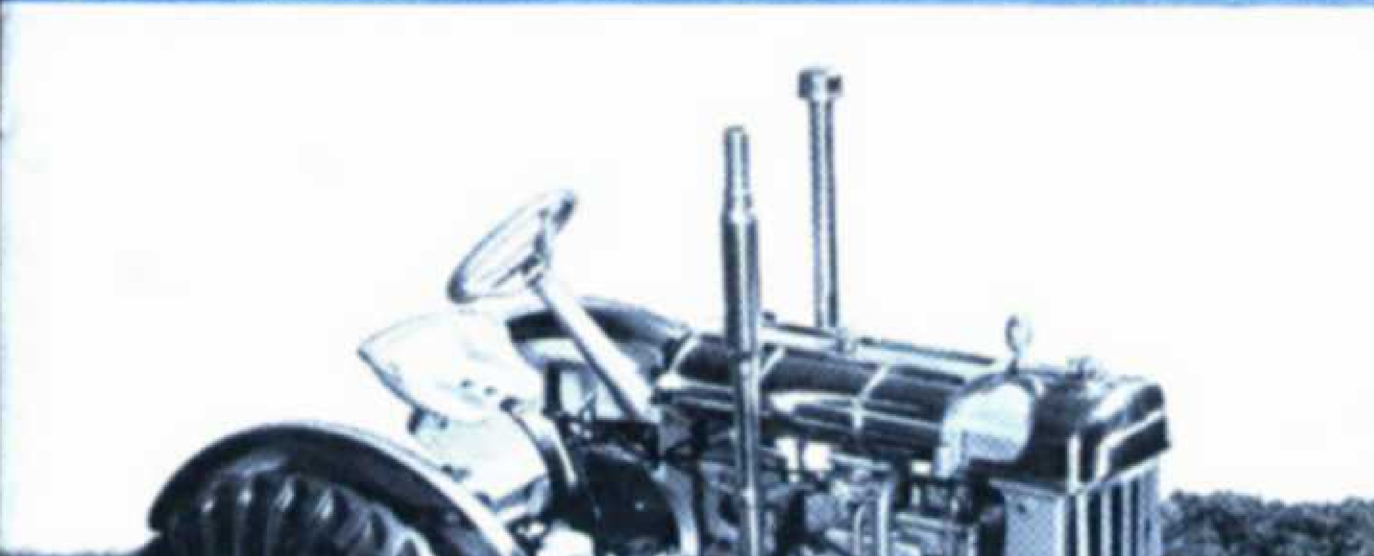
THE MODEL ENGINEER



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EVERY THURSDAY

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THE MODEL ENGINEER

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Our Cover Picture

The model Fordson tractor illustrated here has been constructed by W. H. H. Summers, of Pinner, Middlesex, and entered in the competition section of the "M.E." Exhibition. It was inspired by a visit to the Ford Dagenham works, and has occupied about 3½ years of spare time work. A catalogue and drawings supplied by the makers, and observation of actual tractors through facilities granted by the local Ford agents, Messrs. Reeves, of Uxbridge, gave sufficient information to enable the details to be reproduced. Much of the construction is in sheet brass, with light alloy wheels, the front ones being cast, and the rear ones pressed from sheet metal by means of press tools turned from bakelite. The model is not self-propelled. It may be observed that another model Fordson tractor was illustrated on the cover of the issue for March 3rd last, but it differed from this example in many details.

SMOKE RINGS

Our "M.E." Exhibition Number

AS IS our usual custom, the issue of THE MODEL ENGINEER published on the first Thursday during the run of the "M.E." Exhibition is a special and enlarged issue devoted mainly to the exhibition. It is intended to be not only descriptive of the show but also helpful and interesting to readers and visitors.

Incidentally, we invite all visitors to call at the "M.E." stand where they will find a friendly welcome and something of interest awaiting them. Everything in the hall, however, is worthy of attention : the competition and loan models, the demonstrations and the trade stands, the S.M.E.E. passenger-carrying track, with its annexe where those of the wonderful locomotive stud that are allocated to track duties are serviced, each makes a special appeal to somebody.

Exhibition Diploma of Merit

THIS YEAR we have introduced a new design for the diploma awarded to meritorious entries in the competition section of the "M.E." Exhibition. During the past few years, it has become increasingly apparent that a more appropriate design was wanted, and so it has come about.

The design consists of a blue-grey background, at the top of which is the "hand-and-gearwheel" symbol that has become our trademark, surmounting a shield bearing suitable devices in white. Down each side are sketches, printed in red, depicting many objects beloved of model engineers. In the middle and below the legend "THE MODEL ENGINEER Exhibition," appear the words "Diploma of Merit" in large Old English characters in yellow, outlined in white. Below this is a white scroll-shaped panel in which is printed, in red, the degree of the diploma and lines for entering the recipients name, a description of his exhibit and the signature of the chief judge. At the bottom, in small, white capital letters, is the name of our company.

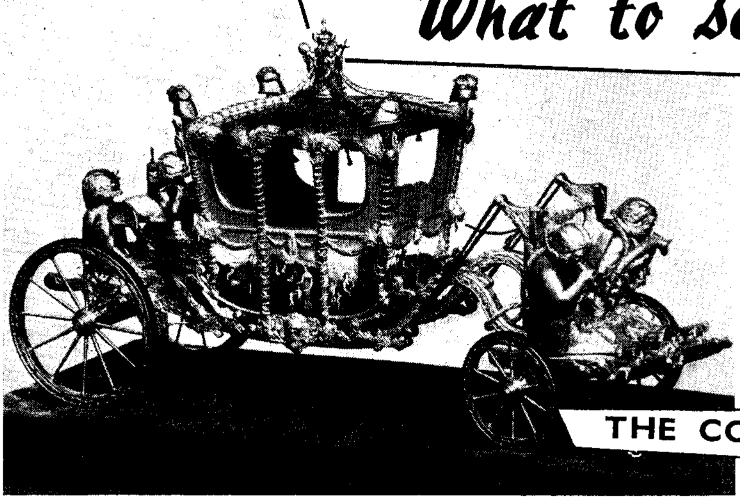
After all, the award of a diploma at THE MODEL ENGINEER Exhibition carries some distinction to its recipient, and the diploma itself should be sufficiently distinctive and dignified to convey the idea.

The "M.E." as Guide

A READER in Suffolk wrote to us a little while ago, to express his gratitude for the influence which he is kind enough to think that THE MODEL ENGINEER has had upon his life's work. His story was interesting as well as gratifying to us; the gist of it was that, in early life, he was much attracted to engineering craftsmanship, but did not become involved until after the 1914-1918 war, when he became a subscriber to THE MODEL ENGINEER and discovered our workshop, then in Farringdon Street.

It was there that he met the late Mr. Percival Marshall and Mr. George Gentry and under their expert and friendly tuition obtained an introduction to craftsmanship which has lasted a lifetime. Our friend does not claim to be a "model" engineer in the strict sense, although he has built some models. Most of his work is freelance as a civil engineer and surveyor, and much spare time goes in devising instruments and gadgets in connection with it and in experimenting and building the prototypes for them in his workshop.

He is kind enough to doubt whether this sort of thing would have been possible without his original "apprenticeship," followed by countless hours "messing about in the workshop" and the diligent study of the articles in THE MODEL ENGINEER. To any youngster with an enquiring mind and an urge to create, he would say that the "M.E." road of approach is the finest one to choose, providing as it does both recreation and education.



What to see at . . .

THE MODEL ENGINEER EXHIBITION

THE COMPETITION MODELS

As is usual, the following article has been compiled entirely from particulars given on entry forms received from prospective competitors, and not as a result of actual examination of the models referred to. Whatever opinions we may express cannot, at this stage, be regarded as final; that must be left to the judges at the exhibition! And that reminds us to add that each of our judges is an expert in his particular subject, and there will be three judges for each class in the competition. There seems to be little likelihood of their task being any less exacting than it usually is.

General Engineering Models

The entries in this section include as usual, a very wide variety of different types of working models, and from the information at present available, there is reason to believe that the quality of the entries is well up to the standard of previous Exhibitions. One of the most interesting and colourful exhibits, without question, will be Mr. H. Slack's steam-driven roundabout in $2\frac{1}{4}$ in. scale. This made its first appearance last year, in an uncompleted state, at the Northern Models Exhibition, and proved to be an outstanding attraction. It has taken about 9,000 hours of spare-time work to construct, over a period of nine years, and it is of special interest to note that all machining was carried out on a home-made treadle lathe. All components can be assembled, dismantled and packed for transport as in full size; the steam engine and mechanical organ, with its robot performers, not to mention all the elaborate ornamention, are true to type.

Messrs. Kent and Tapper, of Smethwick, whose excellent representations of historic types of steam and gas engines have won distinction at several previous Exhibitions, are on this occasion showing a model of the 6 n.h.p. table engine by Robert Napier, of Glasgow, reconstructed from the maker's drawings, dated 1853. This is built to a scale of $1\frac{1}{2}$ in. to the foot, and is largely of fabricated construction, with the exception of the cylinder and valve chest, which are made from castings. All nuts and bolts had to be specially made, and are correct to scale standards.

Another historic steam engine model is the Easton and Amos Grasshopper engine to 1 in. scale by Mr. H. V. Davies. This is built from data published in the "M.E." in 1949, plus observation of contemporary practice at the South Kensington Museum. The period of the prototype is 1861. No castings are used in the construction of the model, and machining was carried out on a converted wood-turning lathe.

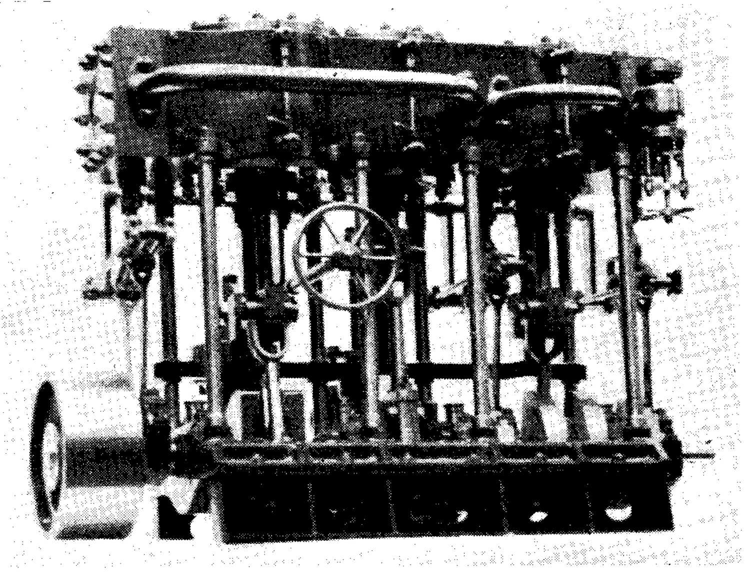
Steam engines built from commercially-made sets of castings include several of the well-known Stuart Turner types, such as the two "No. 9" horizontal engines, by Mr. P. Fenn, of Kenton, and Mr. C. M. Hill, of Gravesend, respectively; a "No. 1" by Mr. C. F. Cox, of Swindon, and a triple-expansion marine set by Mr. D. W. Broughton, of Barnetby, Lincs.

A free-lance horizontal mill engine is entered by Mr. J. Cheesman, of Rossendale, Lancs, and a steam-driven centrifugal fan, incorporating a vertical engine of 1 in. bore and stroke, coupled to a 7 in. fan, based on the type of forced draught fan used in marine practice, is entered by Mr. S. J. Bowles, of London, N.W.10. Miniature steam engines include a $\frac{3}{8}$ in. $\times$ $\frac{3}{8}$ in. vertical engine of fabricated construction by Mr. E. V. Elderkin, of Ruislip, a well-known exponent of this type of model, and a half-size reproduction of the "M.E." "Warrior" vertical twin engine by Mr. W. Cullum, of Filey, Yorks.

A rather unusual type of model is the 1 in. scale mole drainer by Mr. R. W. Palmer, of Southampton, which is a reproduction of the implement used, in conjunction with a haulage engine, to facilitate drainage of deep clay soil. This is constructed, from drawings of the prototype, with the aid of a home-made lathe.

Internal Combustion Engines

Mr. H. Dewhirst, of Baildon, Yorks, has entered an interesting horizontal petrol engine, the general design of which, except for modifications necessitated by the use of liquid fuel, is copied from a 25 h.p. suction gas engine of 1913, to a scale of 1 in. to 1 ft. The castings



A triple-expansion marine engine set, by Mr. D. W. Broughton

were made from home-made patterns, and the camshaft is driven by the orthodox skew gearing, which was cut by hand. The engine is fitted with the usual type of centrifugal governor, and runs at a speed of 950 r.p.m.

Tools and Workshop Appliances

This section is nearly always one of the most interesting in the Exhibition, and the entries this year are as varied and ingenious as ever. Mr. L. Carter, of Kingsbury, London, N.W.9, has entered a power hacksaw machine of the type described in the "M.E." by "Duplex," no castings being used in its construction, the main structural parts being made from steel plate obtained from works scrap. A milling attachment for the lathe, made to the design of Messrs. G. P. Potts and from castings supplied by them, is entered by Mr. D. P. Winks, of Kingsbury, London, N.W.9. Mr. H. A. C. Hunt, of Smethwick, exhibits a 4 in. rotary milling table of his own design, based on that of the Richmond table described in the "M.E." in 1950.

A drilling machine of original design, built from scrap, is entered by Mr. T. H. Lund, of Rugely, Staffs. It embodies several distinctive features, including the use of a table support with a No. 1 Morse taper socket, enabling lathe centres and other fittings to be used, and a right-angle drive using square-section belting on vee pulleys. Interchangeable lathe tool posts of original design, incorporating a height setting gauge, and built from scrap, are entered by Mr. J. Pratt, of London, W.4. A rather unusual lathe attachment is the special swivelling top slide for shaping the teeth of small bevel wheels, by Mr. H. E. Miller, of New Barnet, which includes an indexing dial with provision for zero resetting.

A dial test indicator, ingeniously contrived to utilise scrap material and existing parts, is entered by Mr. H. J. Sales, of New Malden. It is adaptable for use on a surface gauge or machine tools, and is complete with a wooden case.

One of the most unusual exhibits in this section is the model of a water main drilling and tapping machine of the type patented by Talbot in 1910, by Mr. H. Smallbones, of Upper Clatford, near Andover. This appliance is designed to be used without turning off the water at the main; it is clamped to the pipe, using a suitable saddle adapter to form a water-tight joint, and a combined drill and tap enclosed in the body is used to produce the hole, after which it is possible to fit the branch pipe, all without escape of water.

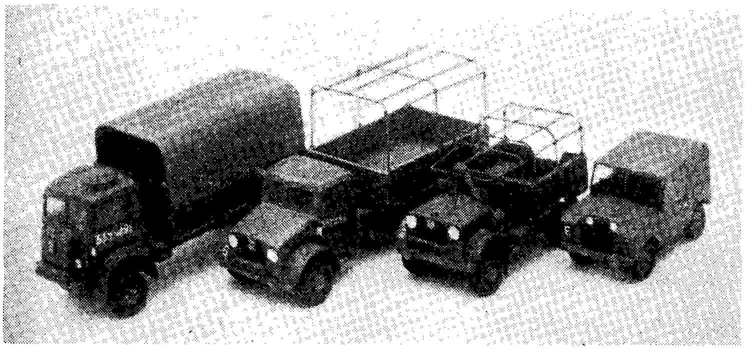
Mr. H. Slack's steam-driven "galloping horses"

Non-working Engineering Scale Models

An interesting exhibit in this section is the $1\frac{1}{2}$ in. scale model of a radar anti-aircraft fire control outfit by Mr. T. R. W. Randle, of Leicester. This incorporates a wheeled vehicle with accommodation for one or more operators, and surmounted by a projector having a rotational movement of 360 deg. and elevation of 90 deg., as used for pin-pointing target position and directing anti-aircraft gunfire.

Mr. W. H. Summers, of Pinner, has entered a 1 in. scale model of a Fordson tractor which appears to show evidence of painstaking detail work.

Miniature models of vehicles in



A group of Army vehicles in 4 mm. scale, by Mr. D. C. F. Fayle

this section include 4 mm. models of a Sentinel 12-ton six-wheeled platform lorry and a Foden eight-wheeled and tipping lorry, both by Mr. R. A. W. Coles, of Bromley, Kent, and a collection of railway " Micromodels " in 1 mm. scale, by Mr. R. Thorpe, of Charlton, London, S.E.7.

Scenic and Representational Models

Architectural models feature prominently in this section, and include several interesting examples of both ancient and modern buildings. The model of the local market place, by Mr. D. C. F. Fayle, of Dursley, Glos, to a scale of 4 mm. to 1 ft., was copied from the actual location, before modern alterations, and is made mainly from cardboard rifle targets and ¼ in. balsa strips, finished by oil paints. Mr. A. D. Griggs, of Norwich, has entered a ⅛ in. scale model of St. Mary Magdalene Church, Norwich, with furnished interior, including the roof timbering, altar fittings, etc., access to which is obtained by removable sections of the roof over the nave and chancel.

The old bridge over the Avon at Melksham, Wilts, has been chosen as a subject by Mr. H. E. Dear, of Leytonstone, London, E.11, from information obtained from photographs and sketches. The model is constructed to a scale of 2 mm. to 1 ft., with a scenic background in low relief.

More modern subjects have been chosen by several other entrants, including Mr. S. E. Hamilton, of Esher, Surrey, who has entered a ¼ in. scale model of a modern garage building on three floors, with petrol station, forecourt and offices ; also Mr. T. A. Thompson, of Hornchurch, Essex, whose entry represents a group of five model shops, and Mr. J. H. Watkins, of East Dulwich, London, S.E.22, who has modelled a terrace of houses in 7 mm. scale, from information in *The Model Railway News.* Other models intended as accessories or scenic effects for model railways include a paint factory in 4 mm. scale by Mr. J. J. Connolly, of Datchet, Bucks.

A scenic model of a chalet at Champery, Valais. Switzerland, is entered by Mr. D. S. Drury, of Sheffield, and scenic models of Army vehicles and equipment by Mr. L. Clow, of Bromley, Kent, and Mr. D. C. F. Fayle, mentioned above.

Horological and Scientific Apparatus

Several of the exhibits in this section have been constructed from information in articles published in the " M.E.," including two electric clocks, one of which, by Mr. L. E. Seager, of Hove, Sussex, is a battery-driven pendulum clock to the design of Mr. C. R. Jones, and the other is a Eureka type balance-wheel clock based on the articles by " Artificer." In the former case all gears were cut in the lathe, with hand-made cutters, but in the latter the gears were taken from an old clock.

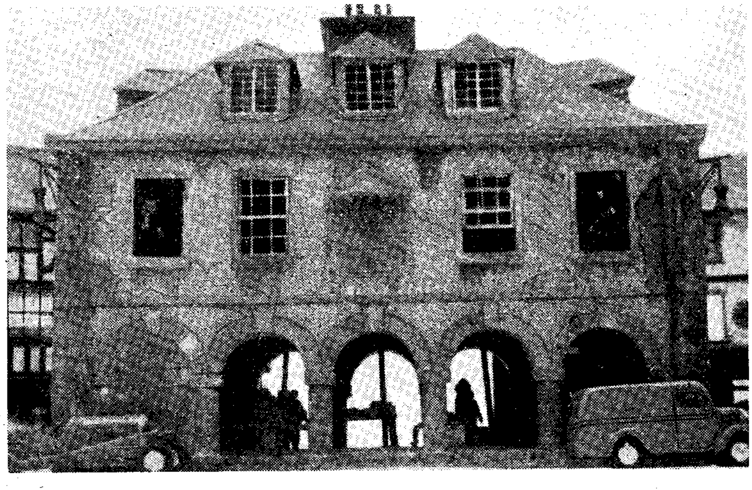
In the spring-driven bracket clock by M. Henri Chavaux, of Victoria, London, S.W.1, the movement is assembled from old parts obtained from various sources. The accent here is on the case, which is of unusual design, with elaborate carving and ornamentation in the style of medieval church wood work.

Mr. P. L. Stiles, of Sheffield, has entered a set of radio control apparatus for a model ship, designed to operate on the 27 mc/s control band, having a standard circuit, but the layout and form of construction are original, the components being protected from spray or other damage by Perspex cases.

General Craftsmanship

As might be expected in Coronation year, some model workers have been inspired to construct a model of the Royal Coach, a very interesting example of which is entered by Mr. D. S. Shearman, of Rochester, Kent ; it occupied over 600 hours in construction, and was a first attempt at figure modelling and painting in oils. (See heading photograph.) Another model of this type is by Mr. R. W. Day, of Ashford, Middlesex, and this also includes models of the horses, riders and grooms.

A model of the Royal Mail Coach of 1837, to ½ in. scale, based on the model in Kensington Palace Museum, is entered by Mr. V. H. Washer, of London, E.C.3, and Mr. F. H. Haskell, of Luton, Beds, has entered



A model of the old Market Place, Dursley, Glos., in 4 mm. scale, by Mr. D. C. F. Fayle

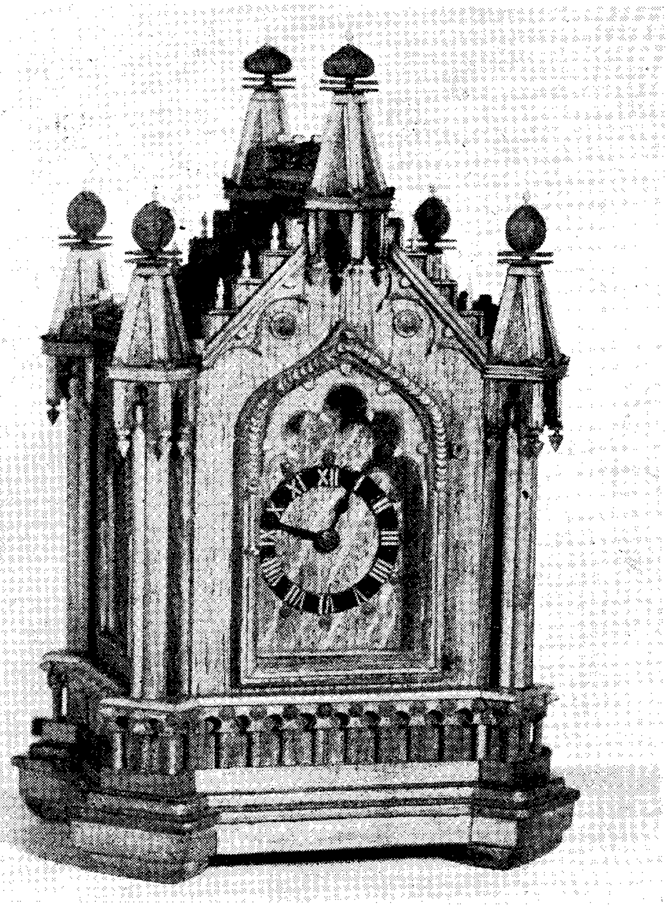
a 1 in. scale model of a stage coach, constructed from information obtained from old prints and books.

Models of farm wagons include an interesting example of a Gloster wagon in 2 in. scale by Mr. C. E. Rogers, of Abergavenny, Mon, copied from an actual prototype in the possession of a local farmer; and an Oxfordshire wagon in 1½ in. scale by Mr. E. J. Perkins, of Aylesbury, Bucks.

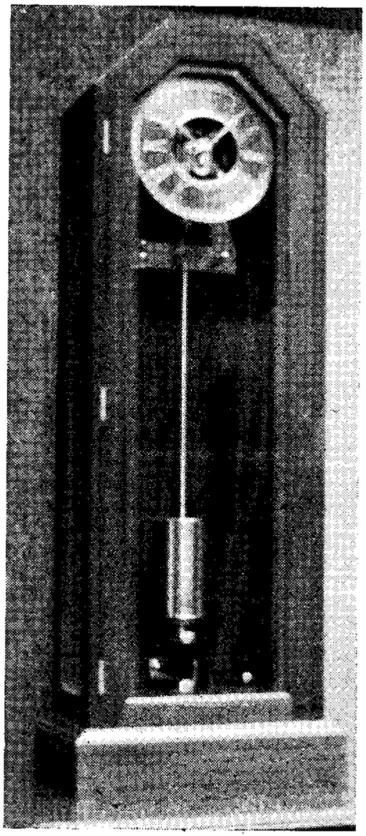
Sports equipment is represented by a 3 in. scale group of summer and winter sports goods, with some indoor games accessories, by Mr. W. Lucking, of Robertsbridge, Sussex, and one-sixth scale models of a rifle and two shotguns on rack, by Mr. L. E. Turnhill, of Bristol.

A representational model of a G.W.R. "King" class 4-6-0 locomotive in cardboard is entered by Mr. D. A. Dubbin, of Fulham, London, S.W.6, and a 1 in. scale model of the *Puffing Billy* of 1813, by Mr. J. S. Youngman, of Chichester.

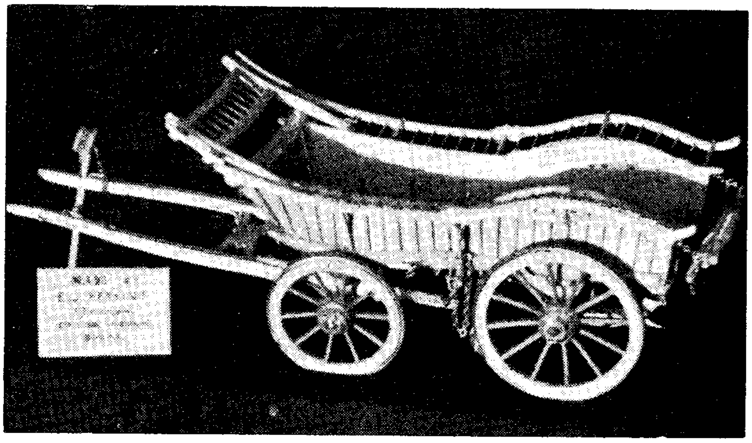
Mrs. Irene K. Ashley, of Ilford,



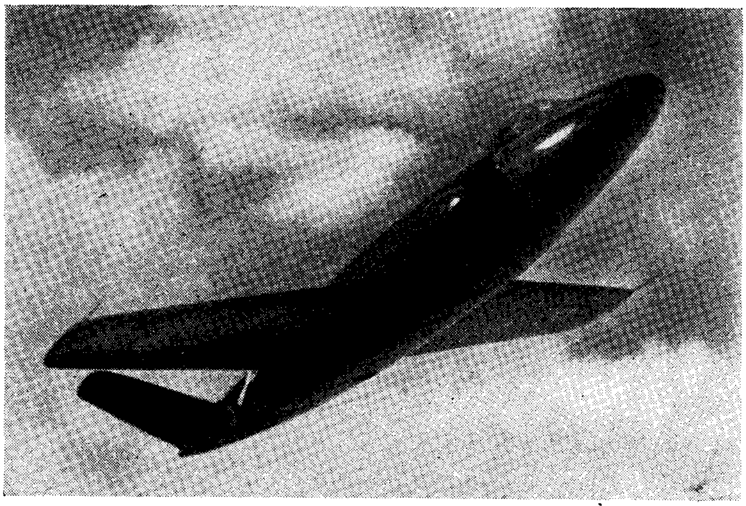
A clock of original design, by M. Henri Chavaux



Mr. L. E. Seager's battery-driven electric clock



A ⅛ scale model of an Oxfordshire farm wagon by Mr. E. J. Perkins



A fine, solid model of the Supermarine 508 by Mr. D. L. Page

Essex, has had the happy notion of making marquetry panels to represent model railway scenery, as background for a cabinet in which her husband keeps his model locomotives and rolling stock, and has entered these as exhibits in this section.

A model of a 50-ft. triple-extension wheeled fire escape, in 2 in. scale, copied from the prototype at the local fire station, is entered by Mr. C. E. Rogers, mentioned above. Mr. H. Chapman, of Lincoln, has entered two model bedroom suites in wood, including beds, wardrobes, and dressing tables, intended for the furnishing of a model bungalow which is yet to be built.

Aircraft Models

The most noteworthy feature of this section is the predominance of scale models—both flying and non-flying—of full-size aircraft. Although the majority of these are of modern prototypes, there is evidence of the great appeal of 1914-18 fighter aircraft. The fact that so many of the entries this year are scale models has contributed a good deal to the attractive appearance of the model aircraft competition section as the purely functional contest type of model, comparatively few of which have been entered, more often than not bear little resemblance to full-size aircraft and are not designed for "eye-appeal."

It is the free-flight flying scale class which will provide the judges, Messrs. A. F. Houlberg, S. D. Taylor and R. F. L. Gosling of the Society of Model Aeronautical Engineers, with their biggest problem. In this class there are so many really outstanding examples of excellent workmanship that it is very difficult to single out models for special mention; but well worthy of note is a fine twin-engined model of the Polish PZL 37 bomber by Z. A. Wodja, of the Polish Air Force Association M.A.C. and a Grumman "Gulfhawk" by P. M. H. Lewis, of London, N.3, who has won awards at previous "M.E." Exhibitions. Capt. C. Milani, of London, S.W.7, has entered two control-line models, a Boeing P26A and a Fairey "Firefly" which are worth close inspection. The R.E.8 entered by E. J. Pithers, of London, W.11 and the Bristol Scout by B. V. Manders, of Enfield, Middlesex, are both up to the high standard that one expects from these two regular entrants in the Model Engineer Exhibition.

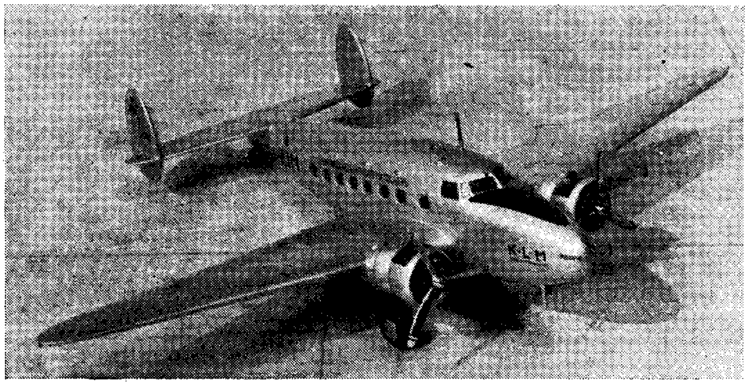
One of the most interesting models in the control-line class is an autogiro by J. D. W. Marshall, of Hayes, Middlesex. This is a model of the American Chupp design and incorporates a 2.46 c.c. "diesel" engine in the rotor head. The majority of the other entries in this class are team racers, but C. Hollowood, of Nantwich, Cheshire, has entered a Class II speed model which features an asymmetric fuselage.

The increase in the popularity of non-flying scale model aircraft is evident from the fact that the number of entries in this class is considerably higher than in previous years. Among them are four from Holland, a Douglas D.C.5, a Convair 240 and a Lockheed "Super Electra" entered by H. J. H. Modderman, of Amsterdam, and a Spitfire II by A. Haazebroek, of Nieuwe Wetering. The Reading Solid-Models Society is well represented by entries from J. B. Llewellyn (Focke-Wulf 190A3, Bristol F2B, Bristol Beaufighter, Focke-Wulf 190D-12), B. H. Webb (Fairey "Tipsy Junior," Gloster "Javelin"), and D. L. Page (D.H. "Comet," Supermarine 508). Another Reading modeller, C. W. Field, has entered a fine model, to 1/48th scale, of the Fairey "Firefly."

Among the surprisingly few radio-controlled models entered is a 7 ft. wing-span Piper Super Cruiser by Master/Sgt. C. H. Crowe, of the United States Air Force who is stationed at Ruislip, Middlesex.

Model aircraft enthusiasts will also find much to interest them on the Society of Model Aeronautical Engineers stand on the dais, and on stand No. 19 where the Royal Air Force have a display of models made by R.A.F. personnel.

(To be continued)



This Lockheed "Super Electra" entered by Dutch competitor, Mr. H. J. H. Modderman, is one of the many fine models in the aircraft section

Special attractions at the Exhibition

THE practical demonstrations of craftsmanship are always a centre of interest at "M.E." Exhibitions, and this year the team of demonstrators will include most of those who have attained popularity in the past, together with new additions to the team. This section will be, as usual, under the supervision of Brigadier Richards.

Mr. F. Pain, of High Wycombe, has become practically a permanent institution at the Exhibition, and will be seen again, amid a fountain of wood shavings, to show what can be done with a simple lathe, a few sharp tools, and a little know-how. Another old favourite will be Mr. J. A. Ibbotson, of Walton Forge, Tadworth, who has on several occasions shown that the fascination of the blacksmith's craft, as expressed in the words of Longfellow, is as potent as ever today—and not by any means confined to school children, either.

The demonstrations of violin making by Mr. C. A. Hoing, of High Wycombe, have proved to be of interest, not only to woodworkers, but also to musicians, and he will again show the construction in detail, from raw material to the finished product, capable of doing justice to the art of the most gifted player.

Brazing and silver-soldering will be demonstrated again by Mr. C. Kennion, and Mr. A. R. Turpin, who is well known as a contributor to the "M.E." on several practical subjects.

A very important aspect of modern technical education will be shown this year in the demonstrations by staff and pupils of Cuckoo Hall Secondary School, in general metal working processes and engine construction.

Among the features of martime interest on the demonstration stand, the one which usually attracts most attention is that of Mr. R. J. Collins building his models of old-time ships. This year he will be working on his model of the 50-gun ship of 1733, which is being described step by step in our companion magazine, *Model Ships and Power Boats*. Readers who are building a model to this series will thus have a most valuable opportunity of bringing to Mr. Collins personally any queries they may have, and of discussing with him the particular problems that have arisen as they proceed with the work. Mr. Collins built a model of this ship some years ago, but in order to incorporate in his articles the results of his more recent experience, he has commenced a new model, and is building it as he prepares his articles. Thus they are based very definitely on the actual construction of the model, which adds immensely to their value.

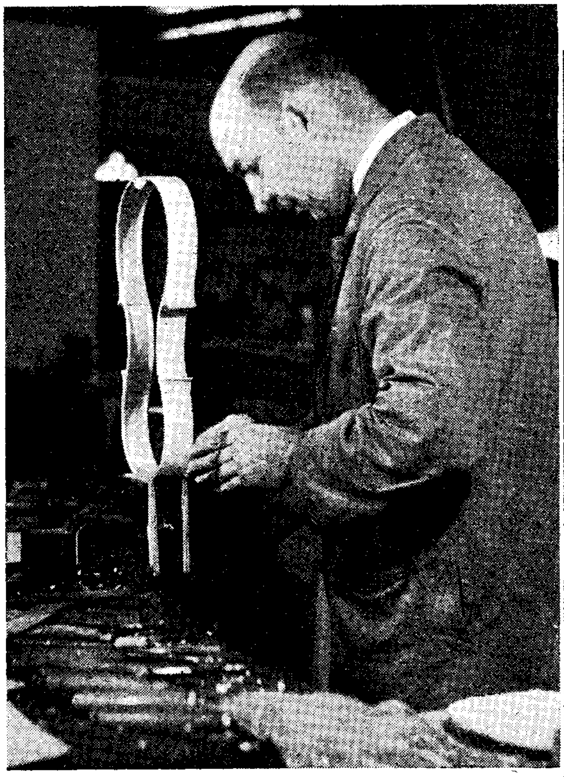
Of recent years, attention has been focussed on the possibility of building working models of ships with hulls of accurate scale proportions. Most builders of working models increase the displacement by adding a little to the beam and depth, and, in the case of all but the expert, this is a course to be commended. However, where the model is considered as an ornament, or at least something to be looked at with pleasure and satisfaction when it is not actually sailing, this exaggerated underwater body is apt to jar on the susceptibilities of the more discerning. To overcome the difficulty a new technique in hull construction has arisen. Instead of building the hull of brass strakes on tee or angle frames, the new idea is to build the hull of tinplate, using transverse strips of the same material to hold the strakes together, and strengthening the shell, after its removal from the wooden former, by the insertion of a few bulkheads. In this way the hull weighs less than half the weight of a hull built on the older plan, and actually it is quite as strong and rigid. As there are no frames, the power unit, whether steam, internal combustion, or electric, can be based at the very lowest point of the inside of the hull, and by building the superstructure also of tinplate or very thin three-ply, the weight distribution can be arranged so as to ensure stability. Mr. F. C. Chapman has demonstrated this method of hull construction in recent exhibitions, and will once more be found at work.

Mr. G. H. Draper, who has already established a reputation for himself in miniature ship-modelling, has of late made a close study of the construction of open boats. His models of a series of naval boats in last year's exhibition, although built to a larger scale than is usual with miniatures, were, in their exquisite

Brigadier Richards (right) assisted by Mr. F. C. Chapman, preparing a locomotive boiler for brazing

detail, masterpieces of miniature modelling. This year he will be found on the demonstration stand, where he will be building his boats. The lifeboats are frequently the worst part of a ship model, and Mr. Draper is out to help ship modellers to appreciate the possibilities which exist in this phase of their work.

Mr. J. T. Brittain, whose large sailing model of the *Cutty Sark* attracted great attention two or three years ago, will be seen on the demonstration stand this year, giving demonstrations of sail making and planking. These are operations not easy to describe in writing, and we feel sure our visitors will appreciate the opportunity of seeing actual demonstrations. Any modeller, who may be having difficulty in making sails for his boat, is invited to bring his spars, or their dimensions, to Mr. Brittain, who will cut out the necessary paper patterns. This is the most difficult part of the work, for, with ships as with men, the cut of the cloth determines the fit of the suit.



A violin in the making, by Mr. C. A. Hoing

The "Wizard in Wood"—Mr. F. Pain at his M.L.8 lathe

The Water Tank

Much as we would like to increase the size of our tank, this has been found to be out of the question, as the space inside the Exhibition is already too small. Most of the demonstrations this year will be concerned with the radio control of boats. Mr. G. Sommerhoff, whose very successful demonstrations at last year's Exhibition are well remembered, will be in attendance during the first week with two M.T.B.s. One of these lowers its launch, in addition to performing various other evolutions. Mr. H. R. Clayton and Mr. G. A. Nurther are demonstrating with their launches two of which have won high awards at previous exhibitions. Both these builders produce boats which really look like boats. We are not very greatly interested in boats built merely to carry radio control apparatus. As model makers we like to see, first and foremost, a good model of a boat or ship, then, if it is to be controlled by radio, let the radio control apparatus be neat and unobtrusive, and of course, efficient. Messrs. Clayton and Nurthen's boats comply very fully with these conditions and we look forward to seeing them "doing their stuff." Mr. Clayton will only be able to demonstrate in the evenings.

The Guinness Crazy Clock

This is a model of the original clock which made its first appearance at the Festival of Britain, Battersea Pleasure Gardens in 1951, and created a great deal of interest; so much, indeed, that several more of these clocks have been made to satisfy demands for them all over the world. The model incorporates all the mechanical movements of the full-size clock, introducing many of the characters from famous Guinness posters.

Quite apart from its attraction as an ingenious mechanical novelty, this exhibit is quite an achievement in instrument design and construction. Many intricate mechanical and electrical problems have been solved to make it a practical success, and unlike the historic types of clocks in which mechanical figures are introduced, some of the operations it performs are extremely complicated. The mechanical or horological enthusiast will find much food for thought in scheming out how the various mechanisms work.

MINIATURE GRAND PRIX MOTOR RACING

By

Rex Hays

FOR the 1952 MODEL ENGINEER Exhibition, at the New Horticultural Hall, Westminster, miniature Grand Prix motor racing was presented for the first time with considerable scenic detail; moreover, it was presented over the longest and most arduous circuit in the world, a circuit upon which certain experts agreed it was next to impossible to run 1.5 c.c. miniature cars at all—let alone race them. The track was 378 ft. round and included 50 ft. of 1 in 6 gradient uphill and 50 ft. at an average of 1 in 9 downhill. The whole layout amounted to an experimental test ground for the advancement and development of realism in miniature Grand Prix motor racing and as such, was extremely interesting, and during the latter part of the exhibition quite successful.

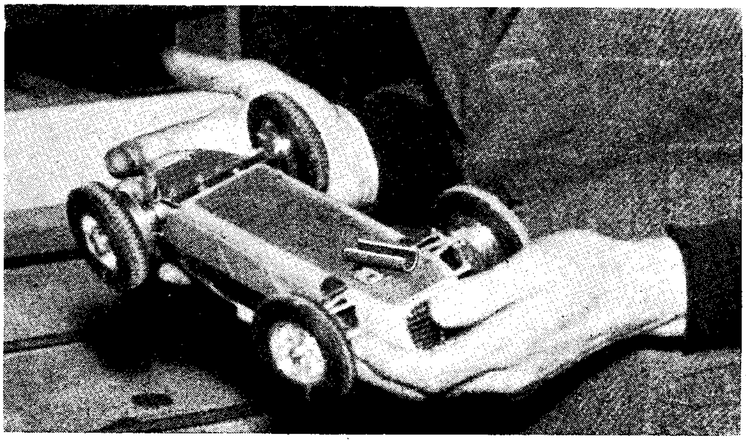
It became evident very early in our experimental racing on this hilly circuit that the accepted method of anchoring the cars to the guide rails by the usual roller principle was unsatisfactory—not a single car completed even one lap, the main trouble being caused by the sudden changes of direction from level running at comparatively high speed to plunging down a gradient of 1 in 6 at ever increasing velocity and flattening out again at the bottom. Although the roller guide mechanism was precision made, the main plate being of ⅛-in. steel, it is a fact that the car's tendency to carry straight on instead of following the changes of direction downhill was never overcome, and the rollers always rolled themselves free of the guide rail—the most spectacular crashes at high speed resulting on every occasion.

I had been more or less prepared for something of this kind to happen and had designed a new type of leading guide and made a prototype in brass, just to see if it functioned in the general sense, and as a matter of fact it proved highly successful even in brass. The downhill speeds of between 50-60 m.p.h. leading into severe, almost right-angled, corners proved too much for the material, but even so a Ferrari fitted with this device did 10 very spectacular laps before it "ran out of road" on a corner due to the failure of the material—which was to be expected. Made up in steel, however, these front guides are excellent and far better in operation. They have the added advantage, where realism is concerned, of being almost invisible.

The all metal clutches gave considerable trouble through overwork, resulting in overheating. No circuit devised up to that time could have demanded more from the transmission. They had to grip powerfully to take a 2½ lb. car up 25 ft. of 1 in 6 from almost a standing start, and from gripping fiercely to slipping freely for three sharp left-hand bends and one sharp right-hand bend following one another in quick succession at the point of the highest speed on the course. This all-metal clutch has been abandoned and a floating shoe Ferodo clutch substituted, which we find vastly superior.

All the problems and weaknesses in the racing of 1.5 c.c. cars over a mountainous circuit were gradually

(*Continued on page* 190)



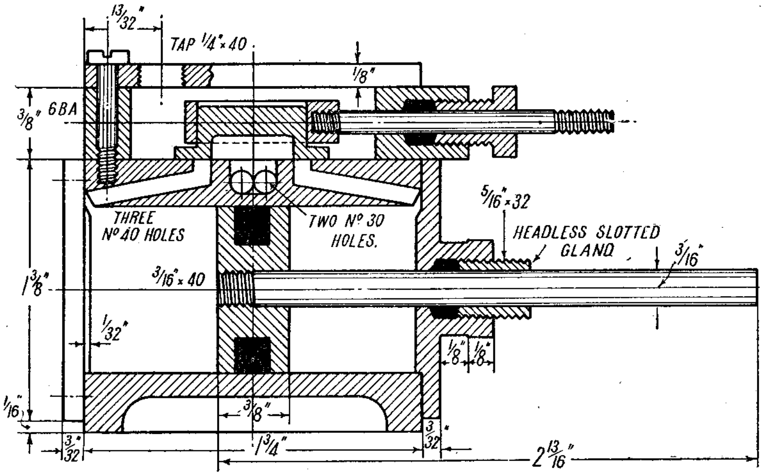
L.B.S.C.'s Titfield Thunderbolt

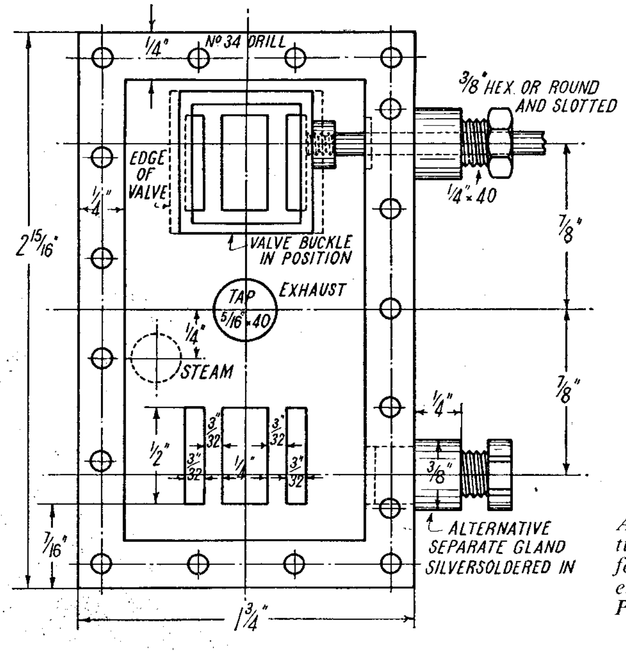
IN $3\frac{1}{2}$ AND 5 INCH GAUGES

THE cylinders for both $3\frac{1}{2}$-in. and 5-in. gauges are plain straightforward jobs, the former size being very similar to those that I described for another old-timer, to wit *Jenny Lind*; the larger size belong to the same family as *Maid of Kent*. Whilst the cylinder block is of the real old-fashioned type, the ports, valves, and setting are in accordance with the practice which has given every satisfaction on other locomotives described in these notes. I haven't been able to manage the drawings for both sets of cylinders this week—the heart is willing, but the flesh is weak—but here are those for the $3\frac{1}{2}$-in. gauge engine; and if our 5-in. gauge friends will possess their souls in patience for a few more days, the larger size will be shown next week, circumstances and the K.B.P. permitting. As the machining and fitting job is practically the same in both sizes, one description should suffice, if I call attention to anything which might differ, as we go along; so let's hope everybody will be satisfied!

How to Set up the Castings

If your lathe is big enough to carry the casting mounted on an angle-plate on the faceplate, I recommend that position for the jobs of boring and facing, as it is so easy to locate the bores and get them exactly parallel. First, check position of coreholes. If they are at correct centres, $1\frac{3}{4}$ in. in $3\frac{1}{2}$ in. size, and $2\frac{1}{2}$ in. in 5 in. size, and at the right distance below portface, no marking-out will be necessary. If the coreholes are out, smooth off one end of casting with a file, plug the coreholes with bits of wood, marking centres on same, and scribe circles to indicate position and diameter of bores. Smooth off portface with a file. Mount an angle-plate on the faceplate, and set the casting on it, portface down, overhanging edge of plate by $\frac{1}{4}$ in. or so, and securing with a bar across its back, held down by a bolt at each end. Set the side of the casting approximately square with the faceplate, by applying a try-square to it, stock to faceplate, and blade to casting. Tighten the clamp bar, then adjust angle-plate on faceplate until the corehole, or marked circle, runs truly. This can be tested with a scribing-block on the lathe bed, setting the point of the needle to the circle, or edge of hole, and adjusting the angle-plate until the needle follows the full circumference; but if the corehole doesn't wobble visibly when the lathe is running, it will be O.K. It's "all wrong," of course, to say things like



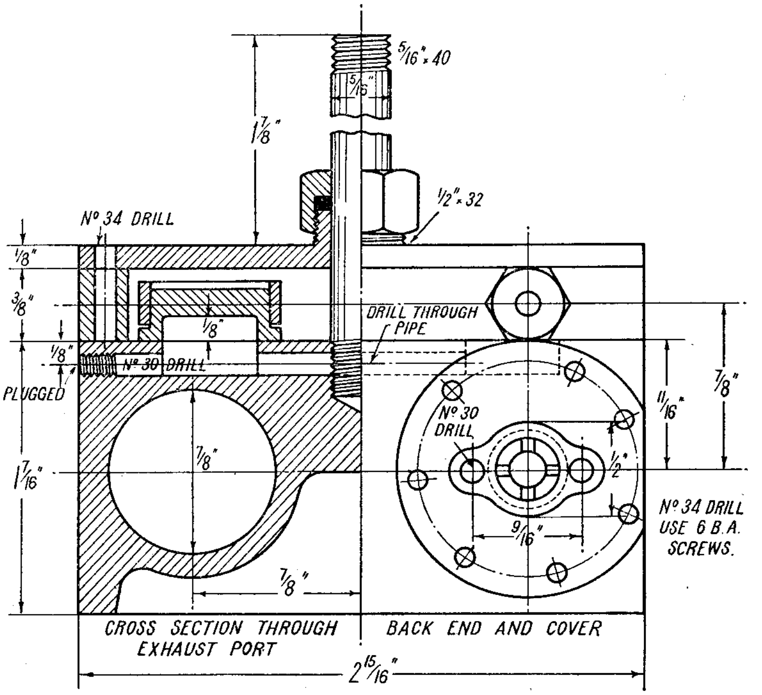


Above — Section of cylinders for $3\frac{1}{2}$-in. gauge engine. Left— Port face and steam chest

that; but as far as your humble servant is concerned, life's too short to bother about working to the "laws of the Medes and Persians," when the same or even better (and certainly quicker !) results can be got by much simpler methods. Bolt a balance-weight of some sort to the faceplate, opposite the angle-plate, so that the shop doesn't rock when the lathe is running. I use an old weight out of a lavatory cistern.

square, allowing the cutter to project $\frac{1}{8}$ in., and this merchant should go through without springing !

If you have a parallel reamer the correct size for the bore, continue boring until the "lead" end of the reamer will just enter, leaving only two or three thousandths to come out, when reaming. If no reamer is available, bore to finished size,



Part section and end of cylinders

taking the last two cuts, in and out, without shifting the cross-slide. This will give a good finish.

If the lathe has a self-act, or the saddle is operated by a hand-wheel, use either for boring ; but if the lathe is plain, with only a fixed-position slide rest, the top slide must be set to turn parallel before attempting any boring. Chuck a piece of round rod, a little longer than the cylinder casting, in the three-jaw, and take a fine cut over it, checking diameter at ends with either micrometer or calipers. If the "mike" indicates only a variation of 0.0005 in. between ends, or you can't detect any difference in the feel of the calipers, the top slide is set O.K. If there *is* an appreciable difference, just reset, and repeat turning and gauging operations. You'll probably hit the bullseye at the third shot !

When one bore is finished, don't on any account shift the casting on the angle-plate, but slack the bolts holding angle-plate to faceplate, and move the angle-plate bodily until the second corehole or marked circle runs truly ; tighten bolts and repeat boring operation. The casting can then be removed from the angle-plate, and mounted on a stub mandrel held in three-jaw, for facing off the other end. Note : if the first end has been marked with circles, *don't* face it off before boring, or you've had it, as the second circle will be wiped out. Do the facing after setting true for the second bore.

Boring Cylinders and Facing Ends

If the coreholes were true, first face off the end of the casting with a round-nose tool set crosswise in the rest. Take off half the difference between the length of the casting and the finished length. Then bore out with an ordinary boring tool, taking a deep first cut, to clean out scale and skin from the corehole. I always use boring tools with the overhanging part as big as the corehole will allow, to avoid springing. A jolly good boring-tool can be made from a piece of square bar, with the end turned circular for a distance equal to a little more than the length of the casting. A $\frac{1}{4}$-in. cross hole is drilled about $\frac{1}{4}$ in. from the end, and tools made from $\frac{1}{4}$-in. round silver-steel to fit it. These are clamped by a set-screw in the end. For a $\frac{3}{4}$-in. corehole, the bar could be $\frac{5}{8}$ in.

Portface and Sides

Up-end the casting on the angle-plate, and secure it with a bolt through one of the bores, using a soft washer under the nut, to prevent damage to the machined surface. Set it with the portface overhanging the edge of the angle-plate by about $\frac{3}{16}$ in. and with both bores exactly the same distance from the faceplate, easily measured by calipers. Adjust the angle-plate so that the casting runs as centrally as possible on the faceplate, or there will be an earthquake when the lathe is started. Face off with a round-nose tool set crosswise in the rest, until distance between bores and portface is exactly $\frac{1}{4}$ in. in the $3\frac{1}{2}$ in. size, and $\frac{3}{8}$ in. in 5 in. size. Slew the casting around a quarter-turn, and set with try-square, stock to faceplate, and blade to machined portface. Face off the side of the casting, until in the $3\frac{1}{2}$ in. size you are within 5/32 in. of the bore, or $\frac{3}{16}$ in. in the larger size. Slew casting around again a full half-turn, reset with try-square, and machine off the other side in similar fashion. Both sides will then be dead square with portface, and parallel with each other ; that is, if your workmanship is not faulty. The overall width of the $3\frac{1}{2}$-in. gauge cylinder block should be $2\frac{15}{16}$ in. and the 5-in., $4\frac{1}{8}$ in.

Alternative Machining

If the lathe is too small, or too rickety-rockety to carry the casting on the faceplate, it can be mounted on the saddle, and fixed with a bar and bolts, as mentioned above. The centres of coreholes or marked circles must be in line with lathe centres. Put a boring bar through the corehole, set it between centres, and put a bent scriber needle in place of the boring tool. Set the casting so that the needle point follows circle or edge of corehole, when lathe mandrel is revolved. Replace scriber needle with boring bit, set the bit out far enough to take a cut from inside the corehole, and feed the casting on to the cutter either by the self-act, or by turning the lead-screw by hand wheel. Boring bars

can be home-made in two wags of a dog's tail, being merely a bit of steel bar of suitable size, with centre holes at each end, and a cross-hole in the middle, in which the boring bit is placed, and held by a set-screw. The cut is put on by withdrawing the tool a weeny bit from the bar. For a fine finish, take the last two or three traverses without shifting the tool.

Hand Reaming

The mandrel of the usual small home-workshop lathe is far too small to admit a $\frac{7}{8}$-in. reamer, let alone a bigger one, so that reaming will have to be done in the bench vice by hand. Use soft metal clams on the vice jaws, to hold the machined casting. Operate the reamer with a big tap-wrench, twisting and pushing at the same time ; put some cutting oil on the reamer, and don't hold the tap-wrench tight enough to force it to one side, or the bore will come out taper or belled. Being still pretty strong in the wrist, I usually put a big lathe carrier on my reamer, and twist "single-handed." If the edges of the reamer are oilstoned slightly, and you don't go what my old granny called "too randy" at it, the bores should ream dead true and with a surface like glass.

Port Cutting

For $3\frac{1}{2}$-in. gauge engine, mark out the ports as shown on drawing. They are cut in the same way as given for single cylinders. Though square ends are shown, it doesn't matter a bean if they are rounded. Up-end the casting on the top slide, or bolt it to a vertical slide, setting it so as to bring the port to be cut at lathe centre height, and put a slot drill, or end-mill of suitable size, in the three-jaw. Feed on to the cutter with the top-slide, and traverse across, with cross-slide. Be careful to avoid "overshooting the platform," by counting the number of turns of the cross-slide handle, or better still, putting a temporary stop on the slide. In days gone by, when I used the lathe for portmilling, I made two clips to go over the guides on my lathe, and they did the trick, saving much time.

If a vertical slide is used, the exhaust port can be cut with the same tool as the steam ports, by taking three or four cuts at different levels ; the height adjustment of the slide allows for this. If you haven't a vertical slide, take my tip and get one as soon as possible ; that is, of course, if you have no milling machine. I don't have occasion to use a vertical slide now, as I have both horizontal and vertical millers ; ports are cut on the vertical miller, holding the casting in a machine vice on the table of the machine, using dental burrs for the narrower ports, and home-made slot drills for the wider ones.

Ports are easily cut by hand, if a row of holes are drilled inside the marked space, and chipped into a slot by aid of a little chisel which can be home-made from silver-steel. Anybody with a good steady hand, "straight eye," and average gumption, can cut quite swell ports if he has enough patience.

Steam Passages

Ports and bores are connected by plain drilled holes. For new readers' benefit, huge connecting "caverns" are not needed ; they have to be filled with steam at or near boiler pressure at each stroke of the pistons, only to be blown to waste when the exhaust port opens. Passages only need to be large enough to allow free movement for all steam required, when the engine is running fast with normal load ; and that isn't much—not on Curly-designed engines, anyway ! I always aim for the lowest possible steam consumption, which explains one of my aversions to the "spam cans."

On the $3\frac{1}{2}$-in. gauge engine, three No. 40 holes will be plenty. File a bevel on the lip of the cylinder bore opposite port, making three centre-pops, a bare $\frac{1}{8}$ in. apart, and drill into the port by setting the casting in a machine vice on the drilling-machine table, slightly tilted. You can gauge the exact tilt needed, by bringing the drill down outside the casting, and sighting it with the portface. When drilling, be very careful as the drill breaks through into the port, or the point will go west ; and drills cost muckle bawbees the noo, ye ken.

If drilling passages by hand, set the casting in the bench vice at an angle, so that you can hold the brace level, and make a beeline for the port. Take the same strict caution as before, as the drill breaks through into the port. Don't overdo it and carry on into the exhaust port !

Exhaust Passages

First, drill the hole for the exhaust pipe in the middle of the portface. In $3\frac{1}{2}$-in. gauge size, this is 9/32 in. diameter and $\frac{3}{8}$ in. deep, and is tapped $\frac{5}{16}$ in. $\times$ 40. Next, mark the centre-line on one side of the cylinder block ; and at $\frac{1}{8}$ in. either side of it, and $\frac{1}{8}$ in. below portface, make two centre-pops. Drill each No. 30, cutting right across the first exhaust port, through the hole for exhaust pipe, into the second exhaust port. To avoid the drill wandering, it would be advisable to put a temporary plug in the exhaust pipe hole, removing after drilling. Tap the ends of the holes, but don't plug them yet, as the pipe has to be drilled through them after final fitting.

An alternative way of drilling the "entrance to the way out," is to drill the hole for exhaust pipe a little deeper, then put a 7/32 in. drill down the inner side of each exhaust port, and drill on the slant, into the central hole ; this will be shown on the drawings of the 5-in. gauge cylinders.

Cylinder Covers

The front covers are just plain turning jobs. Chuck by spigot, face off, turn edge to diameter, and cut back the face sufficient to leave a 1/32 in. register, which will enter the cylinder bore an easy fit. Saw or part off chucking spigot, reverse in chuck, holding in a stepped bush, and face the other side. Drill screw holes as shown, setting them out to miss the bevel where the steam passages emerge. The easiest way to locate these holes, is to get a steel washer the size of the cylinder cover, or a little larger. Bore out the hole to fit over register, then set out and drill the screw holes on it. Use it as a jig to drill all four covers. I was much amused some time ago, to see somebody writing in a contemporary journal, and claiming this age-old wheeze as his very own idea ; other ancient and discarded items from these notes were also trotted out as new and original !

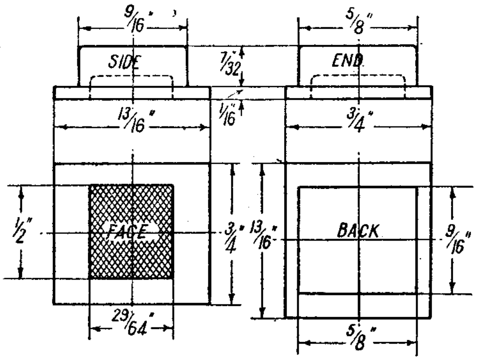
After turning flanges and registers of the back covers (the registers in this case should fit exactly) centre, and in $3\frac{1}{2}$-in. gauge size, drill through No. 12. Reverse and rechuck in stepped bush (making stepped bushes was fully described in the notes on *Tich*, especially for beginners) face off the guide-bar flange, and run a $\frac{1}{8}$-in. parting tool behind it, reducing the part behind the flange to a shade under $\frac{7}{16}$ in. diameter. Open out the stuffing-box with a 9/32-in. pin drill, and tap $\frac{5}{16}$ in. $\times$ 32, guiding tap by aid of the tailstock chuck ; this will ensure that the holes for piston-rod in both cover and gland, will be concentric. The gland has no head, as there is no room for one between the guide bars ; the full-sized engine had a studded gland with an oval head, the narrow part of the oval being between the guide bars. This is useless for the little one, as the weeny nuts would be inaccessible. The

gland for $3\frac{1}{2}$-in. gauge engine is just a $\frac{3}{8}$ in. length of $\frac{5}{16}$ in. round rod, with a No. 12 hole through it. However, to ensure that the hole is dead in the middle, which is most essential for easy working, chuck a bit of $\frac{3}{8}$ in. round bronze or gunmetal rod in three-jaw; face, centre, and drill No. 12 for $\frac{1}{2}$ in. depth. Turn the outside to $\frac{5}{16}$ in. diameter, and screw it with a die in the tailstock drilling machine table, with the front covers off. If you haven't a drilling-machine, use the lathe, holding the cylinder block against a drilling pad on the tailstock barrel, as these holes *must* be dead square with the cylinder block, otherwise the guide bars will be all skew-whiff.

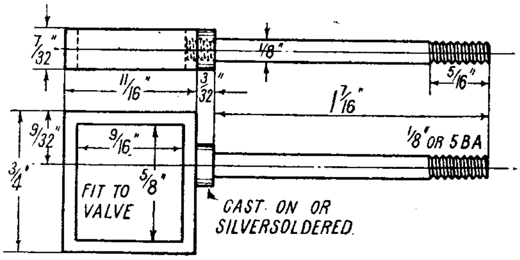
Pistons and Rods

On the $3\frac{1}{2}$-in. gauge engine, the

just file them smooth. Mark and centre bosses for valve-spindle holes, and drill with the casting held in a machine-vice either on the drilling-machine table, or against a drilling pad in the lathe tailstock. Open out with a pin-drill to tapping size, and tap with a pilot tap if available; if not, hold the tap in the drill chuck to start it truly. The glands may be either hexagon-headed, or circular



Slide valve



Buckle and spindle

holder, then part off at $\frac{3}{8}$ in. from the end, and cross-slot it with a watchmakers' flat file. See coming drawings for the 5 in. gauge sizes.

Use the cylinder covers as jigs to mark off the screwholes on the cylinder casting. Any position will do for the front covers, as long as the screwholes clear the bevels; but the back covers must be drilled as shown, as the position of the guide bar flange has to be taken into account. Temporarily clamp each cover in place, and for the $3\frac{1}{2}$-in. gauge engine, run the No. 34 drill through the holes in covers, making countersinks on the cylinder block; follow with No. 44 drill, and tap 6 B.A. When setting the back covers, see that the guide bar flange is horizontal.

Put the two back covers on temporarily, with a couple of screws in each; file projecting part flush with sides. Put a temporary plug in the stuffing-box hole, with the centre marked on it. Put the cylinder block, portface down, on the lathe bed, surfaceplate, or something equally flat and true. Set the needle of a scribing-block to the centre of the stuffing-box, and scribe a line across the guide-bar boss; on it, at 9/32 in. ($3\frac{1}{2}$ in.) or $\frac{3}{8}$ in. (5 in.) each side of centre, make centre-pops. Drill smaller No. 30, larger $\frac{3}{16}$ in. leaving the back covers in place, and standing the cylinder block, front end down, on the

piston-rods are $2\frac{13}{16}$ in. lengths of $\frac{3}{16}$ in. rustless steel or bronze rod, with $\frac{3}{16}$ in. of $\frac{3}{16}$ in. $\times$ 40 thread on one end. Screw in three-jaw, with die in tailstock holder. The pistons can be turned from 1 in. round bronze rod, or from castings. Chuck in three-jaw, and face the end; centre and drill 5/32 in. or No. 22 for $\frac{7}{16}$ in. depth. Rough-turn the outside to within 1/64 in. of finished size, and form a groove $\frac{3}{16}$ in. wide, and same depth, with a parting-tool. If rod is used, part off at $\frac{5}{8}$ in. from the end, and repeat operation; castings will be separate, and will have chucking pieces. Chuck rough-turned piston in three-jaw, open out centre hole to $\frac{3}{16}$ in. depth with No. 13 drill, and tap the rest $\frac{3}{16}$ in. $\times$ 40. Put the piston-rod in tailstock chuck, screwed end outwards, run it up to piston, enter the rod in the tapped hole, and screw right home by pulling on the lathe belt. Chuck the piston-rod either in a collet or in a split bush held in three-jaw, and finish-turn piston, with very light cuts, to an exact sliding fit in the cylinder bore. Pistons for 5-in. gauge engine are made exactly the same, but to the sizes shown on coming drawings.

Steamchest and Cover

The steamchest casting can be chucked in the four-jaw, for machining off the contact faces; inside and out can be smoothed off with a file. Cast-on bosses need not be turned;

and slotted, as desired; no detailed instructions are needed for that simple job. Mark off and drill the screw holes as shown. In the drawing, instead of showing them separately as usual, I have superimposed the steamchest on the portface, and outlined the valve and buckle, to give builders an idea of what the whole assembly looks like. Hope this is approved!

If preferred, the stuffing-boxes may be turned from round rod, pressed into drilled holes in the steamchest wall, and silver-soldered. In that case, don't make the spigots long enough to come flush with the inside, but leave about 3/32 in. clearance. This will allow the boss on the valve buckle to have plenty of room. Some of the *Fayette* builders of days gone by, made the spigots fit flush, and then wondered why they couldn't get enough valve travel.

The steamchest cover may either be a casting, or cut from brass plate, $\frac{1}{8}$ in. thick in $3\frac{1}{2}$ in. gauge size. If cast, it will have a boss on it for the blastpipe gland. Chuck it by this, and face off the contact side; then reverse and chuck it in the four-jaw with the boss running truly. Face off, centre, and drill $\frac{5}{16}$ in. clearing, for the pipe. Turn the outside to $\frac{1}{2}$ in. diameter, screw $\frac{1}{2}$ in. $\times$ 32, and make a hexagon gland nut to suit, from $\frac{5}{8}$ in. hexagon brass rod. Temporarily clamp the steamchest to the cover, and

poke the drill through all the screwholes, carrying on through the cover ; smooth off any burrs.

For the $3\frac{1}{2}$-in. gauge blastpipe, cut a piece of $\frac{5}{16}$ in. copper tube, $2\frac{11}{16}$ in. long, put $\frac{5}{16}$ in. of $\frac{5}{16}$ in. × 40 thread on one end, and $\frac{3}{16}$ in. on the other. Screw the longer end temporarily into the hole in the middle of the portface, put the steamchest and cover over it, line up sides of steamchest with sides of cylinder block, and temporarily clamp in place. Run the No. 34 drill through all the screwholes, making countersinks on the portface ; remove chest, drill the countersinks No. 44, and tap 6 B.A.

Valves and Buckles

The slide-valves may be cast, or in $3\frac{1}{2}$-in. gauge size, cut from bronze or gunmetal bar of $\frac{5}{16}$ in. × $\frac{3}{8}$ in. section. If cast, they will be correct shape, with cavities cast in, and will only need cleaning up with a file, to given sizes. If made from bar, the sides can be end-milled exactly as described for axleboxes, either in lathe or milling-machine. The cavity can be end-milled out with the casting held in a machine-vice on a vertical slide ; or it can be formed by hand. Just drill holes about $\frac{1}{8}$ in. deep, all over the marked-out space, and chip them into a rectangle, with a little home-made chisel, as used for hand-cut ports. All dimensions are given in the drawing.

The valve buckles may either be cast, or in the smaller size, bent up from 16-gauge brass strip, 7/32 in. wide, with a boss of 7/32 in. rod silver-soldered on. If bent, have the joint right in the middle of the boss, *not* at one of the corners. Drill boss No. 40 and tap it $\frac{1}{8}$ in. or 5 B.A., going right through the buckle. The valve spindle is made from $\frac{1}{8}$ in. rustless steel or bronze, a bare $1\frac{5}{8}$ in. long, with 5/32 in. of thread on one end, and $\frac{5}{16}$ in. on the other. Screw tightly into buckle boss, and file off flush inside. The valve should be quite free in the buckle, without being slack.

Before assembling "for keeps," true up the port faces, valve faces, and contact surfaces, by rubbing on a piece of fine emery-cloth or other abrasive, laid business side up, on a true surface. Screw the exhaust pipe in, drill through it as shown, and plug the ends of the holes in the casting. The pistons may be packed with a ring of braided square graphited yarn ; the glands with ordinary graphited yarn, and the cover and steamchest joints made with oiled paper, or 1/64 in. Hallite or similar jointing. Hexagon-headed screws may be used, but as most of them are out of sight, it doesn't really matter. The cylinders for the 5 in. job are made same way. Guide-bars, crossheads, etc., next.

MINIATURE GRAND PRIX MOTOR RACING

(*Continued from page* 185)

overcome and the development towards perfection was to us astonishingly like the real thing, which I was engaged upon in years gone by; now at this year's exhibition we hope that we shall be able to present not a test track for experimental purposes but some really spectacular Grand Prix motor racing.

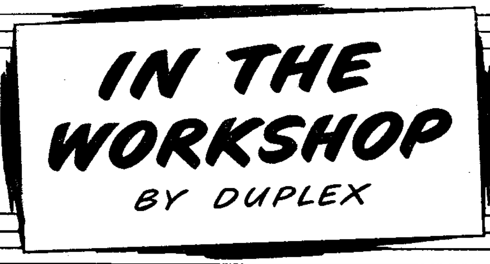
This year's visitors will see that the circuit is shorter, and I think more interesting, as almost all of it will be visible to all spectators. The cars racing will include Ferrari, H.W.M., Gordini and Alfa Romeo—the last named will be the same car which, it may be remembered, I built and wrote about in previous issues of THE MODEL ENGINEER and which has been brought up to date with the latest improvements gleaned from our experiments.

Other than spectacular motor racing, a feature which we feel is so important to the presentation of a scaled-down sport of this kind is the setting which must have the Grand Prix atmosphere, and it is very gratifying to us to know that all the leading manufacturers regard this "Ten Days Motor Racing Meeting" as the real thing and have arranged to take their pits and position their publicity banners in exactly the same manner as they do at Silverstone or on the Continent, and in consequence when you see this circuit—which is to be the scene of 10 days almost continuous racing—you will not only be seeing scale model cars racing (and they are scale models, each type built off the actual cars measured up in the paddocks of the great circuits), but you will see real trees and foliage and grass which is actually growing; real banners and pit signs which are not there because they look pretty or authentic, but because they are doing a job of real publicity. What more realistic setting could one wish for ? Then there are the spectators, the pit personnel and the many different "types" which can always be seen round the paddocks of motor racing circuits. These are 1/12th scale figures modelled in clay and produced in commercial porcelain—each one hand painted, again depicting to some extent the "characters" seen at motor race meetings.

Last year when the racing was a real danger to miniature life and limb, we had some of the most realistic crash scenes which, I regret to have to record, met with the unanimous approval of the rather bloodthirsty real-life spectators ! On one occasion a Ferrari and an H.W.M. were racing at terrific speed neck and neck down the straight behind the pits and paddock, when their front roller guides both failed at the same spot—both cars tore free from their rear rollers—actually bending the $\frac{1}{8}$-in. steel plates in the process—the H.W.M. did four complete somersaults down the middle of the circuit, throwing the driver out, and the Ferrari crashed at full speed head-on into the stone wall of the building; neither car was bodily damaged at all, which says a great deal for the French Lime Bodyshells.

On another memorable occasion an H.W.M. ran out of road at about 50 m.p.h., crashed through a chestnut fence and, scattering miniature spectators left and right, hurtled in amongst the trees, its driving wheel churning deep ruts in the real earth, and not only throwing this earth all over the circuit but smothering the real spectators as well. One delighted gentleman—with a moustache of considerable "wing span"—was heard to exclaim in awe-struck tones : "Oh, wizard prang, worth coming to London to see."

So even the disasters were received with pleasure by some, but this year we hope that the "wizard prang" will be replaced by some wizard miniature motoring. We shall be there all the time and hope that, not only will our friends come and see us, but that we shall have the pleasure of a chat about miniature Grand Prix motor racing with anyone who cares to tap us on the shoulder.



AN INTERNAL GRINDING SPINDLE

ALTHOUGH small, hardened steel parts can often be finished to size and fitted by lapping; this method is slow, particularly where more than a very small amount of material has to be removed.

On the other hand, the internal grinding of hardened bearing bushes and collars is comparatively quick and, with proper equipment, accurate results are not difficult to obtain.

Moreover, the grinding spindle illustrated has been found particularly useful for sharpening circular dies after the cutting edges have become dulled or chipped after prolonged use.

Accurate and Expensive

Commercial grinding spindles are made to a very high standard of accuracy and are, therefore, expensive ; either hardened steel bearings are used or special precision-type ball-bearings are fitted, and in either case the design is such that the adjustment of the bearings can be carried out with great exactness. Although this degree of precision is not, of course, claimed for the spindle under review, it has, nevertheless, been accurately made as far as workshop conditions allow, and the results so far obtained when working have been in every way satisfactory. During short runs at 40,000 r.p.m., the vibration was negligible and a high finish was given to the work.

Standard commercial ball-bearings have been used of the type that can be bought quite cheaply at surplus stores. The inner and outer races of both pairs of bearings have been end-located, so that no end-float is present and no allowance is made for expansion.

Light Construction

However, the bearings can be cheaply replaced if they become worn after prolonged use. In the past, grinding spindles intended for amateur use have sometimes been too lightly constructed and have failed because of lack of rigidity in the work spindle itself ; but in the present instance, as will be seen in the sectional drawing, a massive spindle of undoubted rigidity has been fitted. Particular attention has also been paid to reducing as far as possible the overhang of the grinding wheel mounting. For the actual grinding wheels, commercial mounted points are used ; these consist of an abrasive wheel or pencil, of a diameter as small as 3/32 in., permanently fixed to a $\frac{1}{8}$-in. dia. arbor. The mounted points manufactured by the Universal Grinding Wheel Co., of Stafford, have been found to give excellent results but it is advisable to consult the makers' lists in order to obtain the wheels best suited for the particular kind of work undertaken.

The Construction

To relieve the load on the individual bearings, a pair of bearings is fitted at either end of the spindle.

It is, of course, essential that all the bearings should be accurately aligned, otherwise an excessive and irregular working load may be imposed on the bearings and they will eventually suffer damage. In the past, when machining the bodies of toolpost grinders to form the bearing housings, the body itself was first fitted with a mounting shank or bracket, so that the assembly could then be secured to the lathe saddle in its final working position ; this enabled the housings to be machined to size at a single setting by means of a long boring bar, furnished with an adjustable, inset cutter at either end. With the grinder under construction, however,

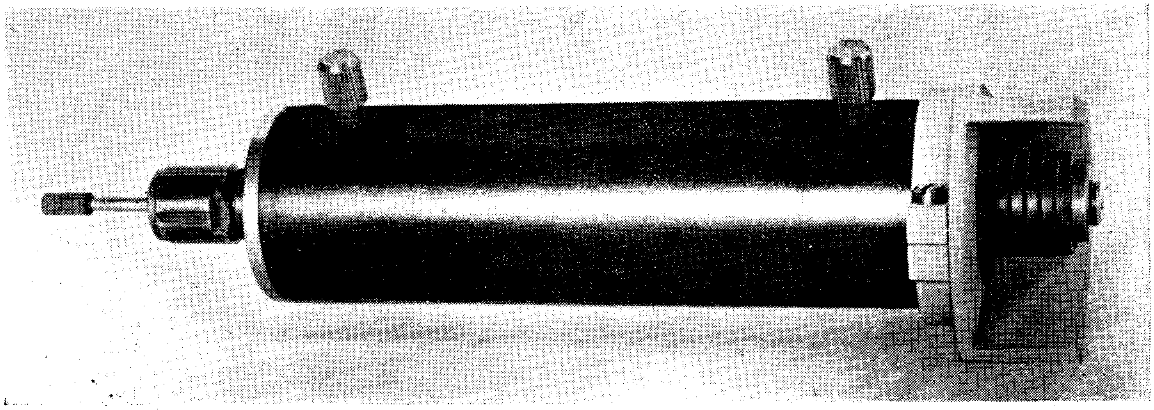


Fig. 1. The finished grinding spindle

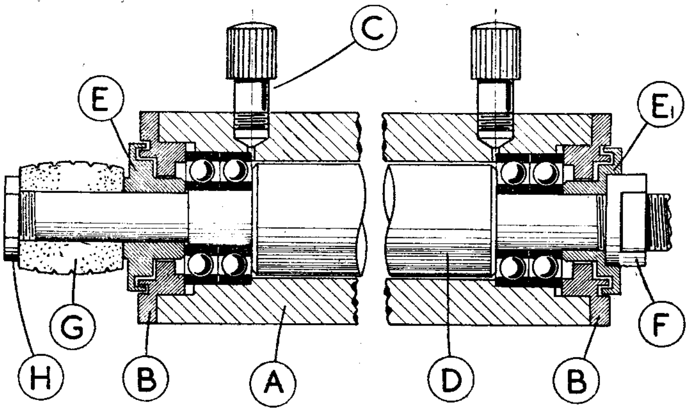


Fig. 2. A—the body ; B—the bearing caps ; C—the lubricators ; D—the spindle ; E and E.1—the dust excluders ; F and H—the spindle collars ; G—the pulley

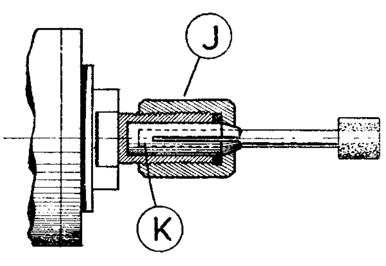
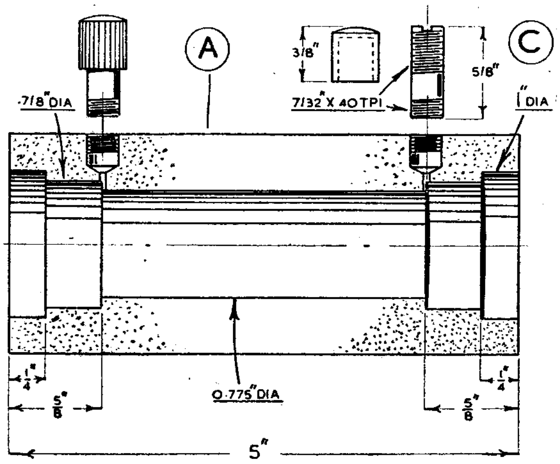


Fig. 3. End of the spindle, showing the chuck collar (J) and the collet (K)



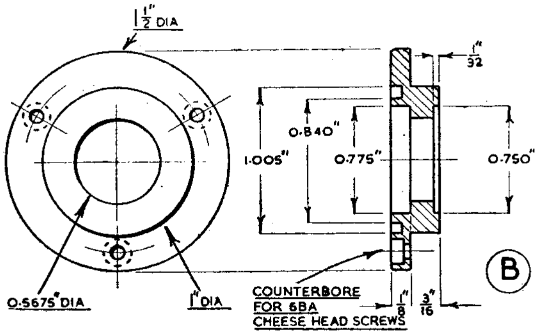


Fig. 5. The bearing caps

Left—Fig. 4. Showing the dimensions of the body and lubricators

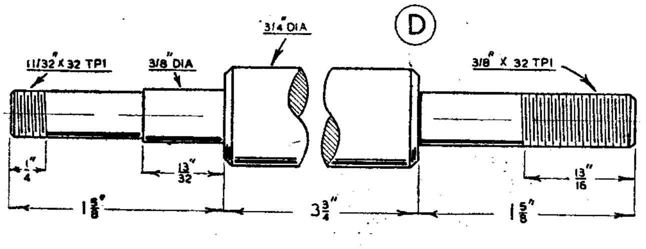
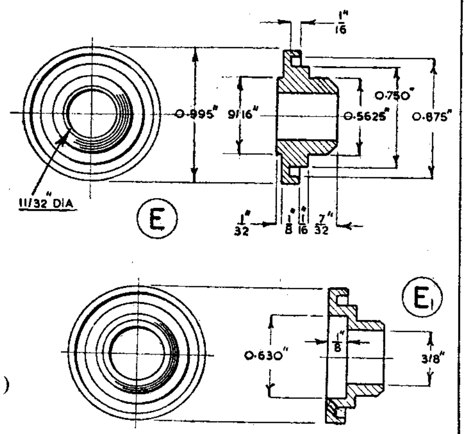


Fig. 6. The spindle



Right—Fig. 7. The left- and right-hand dust excluders (E) and (E.1)

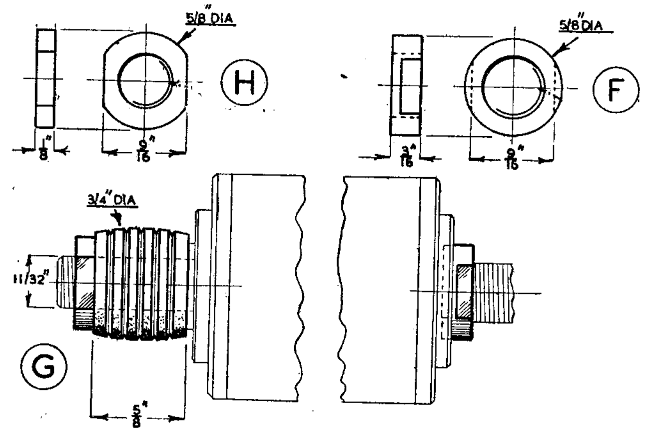


Fig. 8. The right- and left-hand spindle collars (F) and (H); the pulley (G)

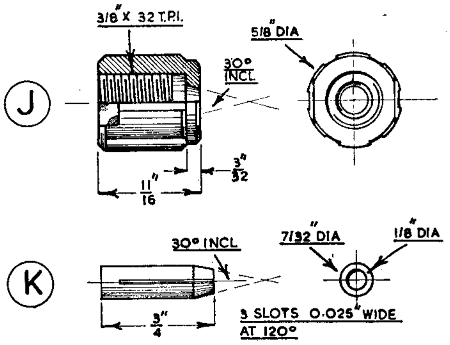


Fig. 9. The collet chuck collar (J) and the collet (K)

the mounting formed a separate assembly and was not fitted until later. After the $1\frac{1}{2}$-in. dia. mild-steel bar for the body had been turned parallel on the outside, it was bored to clear the $\frac{3}{4}$-in. dia. spindle while held in the four-jaw chuck and supported at the outer end in the fixed steady.

At the same setting, the bearing housing and the cap recess were finished to size to allow the ball-bearings to enter as a light push-fit. For machining the second bearing housing and cap recess, the body was centred and driven by being pressed on to a shouldered mandrel, turned in place when gripped in the four-jaw chuck ; the overhanging end of the body was again supported in the fixed steady. To complete the machining of the body, the holes for the lubricators are drilled and tapped, and, when doing this, the oilways should be drilled clear of the abutment faces for the outer bearing races, for any burrs in this situation are difficult to remove and will upset the alignment of the bearings.

The Bearing Caps (B)

Machining these fittings from steel, brass, or duralumin rod is a straightforward turning job, and, if a small boring tool is used, no difficulty should be found in forming the annular recess to accommodate the flange of the dust excluder.

With the bearings in place, the cap when pushed home should be just clear of the end of the body. Each cap is held in place by three No. 5 or 6 B.A. cheese-head screws.

The Spindle (D)

This was made of alloy-steel, but ordinary mild-steel will serve quite well. The spindle is turned and screwcut between centres, and it should be noted that the centre formed at the right-hand end is deeply drilled, so that it will remain for further use, if needed, after the bore for the collet has been machined. The details of this end of the spindle are shown in Fig. 3, and the bore to receive the collet is finished to size with a small boring tool, while one end of the spindle is centred in the four-jaw chuck and the other is supported in the fixed steady.

The Dust Excluders (E) and (E.1)

Here again, this is straightforward turning, but note that these fittings serve to clamp the inner bearing races against the shoulders on the spindle ; also, the right-hand part is recessed for the clamp collar in order to reduce overhang.

The Spindle Collars (F) and (H)

To ensure accuracy of alignment, these parts should be screwcut in the lathe. The left-hand collar (*H*) is threaded 11/32 in. × 32 t.p.i. and (*F*) $\frac{3}{8}$ in. × 32 t.p.i.

Before the two collars are finally case-hardened, spanner flats are filed on their sides.

The Driving Pulley (G)

To ensure good wearing qualities, the pulley was turned from Tufnol of the laminated variety with a cotton insert. The surface should be crowned to keep the driving belt in place, and the grooves shown serve as vents to stop air being compressed between the belt and the pulley and causing belt slip.

Fitting the Ball-bearings

As the satisfactory running of the spindle, when in operation, depends

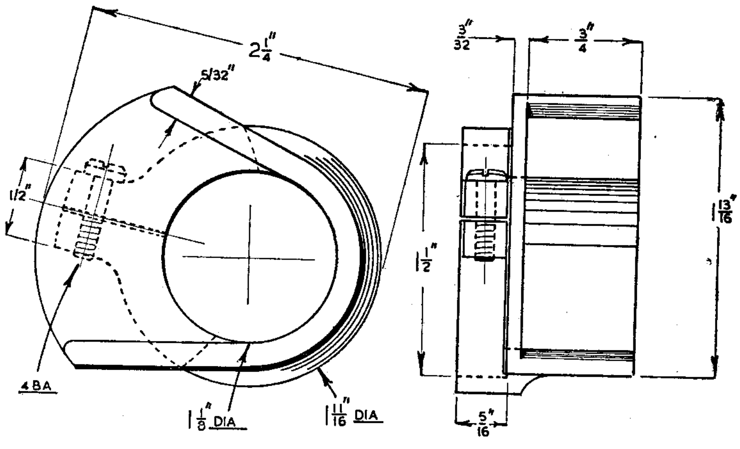


Fig. 11. The pulley shroud

almost entirely on the correct design and proper fitting of its bearings, it is important to select ball-bearings of the right type and to instal them in accordance with the manufacturer's recommendations.

In the present instance, however, the small, S-type bearings were fitted, as they happened to be available, and these have so far given satisfactory service under working conditions.

Light Loads

Bearings of this type are not designed to take more than very light axial loads, as end-thrust causes wedging of the balls in the races and may lead to bearing failure.

When fitting bearings of this kind to the spindle, it is most important, therefore, to avoid imposing end-thrust while clamping the inner races in place by means of the spindle collars. If necessary, shims must be introduced to give the correct spacing and allow the balls to run freely in the centre of the ball tracks.

As advised by the manufacturers, bearings fitted with ball cages are best adapted for running at high speed.

Even Contact Bearings

When fitting the paired bearings, make sure that the mating faces of both the inner and outer races make even contact, as in some bearings the inner races are made slightly shorter than the outer. The two bearings at the left-hand end can be first clamped in place in correct adjustment, and the spindle is then pushed into the body to allow the bearing cap to be screwed down. The inner right-hand bearing is then fitted so that both the inner and outer races exactly bottom against their seatings.

The outer bearing should then make even contact with the inner and, after the cap and dust excluder have been fitted, the bearing assembly is secured by tightening the clamp collar.

Avoid End-Thrust

Although with this form of construction there is no great difficulty in fitting the left-hand pair of bearings correctly, using shims if necessary, it is not quite so easy to fit the right-hand pair without causing end-thrust. If there is any doubt in the matter, it may be as well to adopt the usual practice of clamping the two right-hand outer races, leaving the inner races a close sliding fit so that they can align themselves correctly on the spindle. Where this method of fitting is adopted, the clamp collar, maintaining the dust excluder in place, is finally secured with a locking collar.

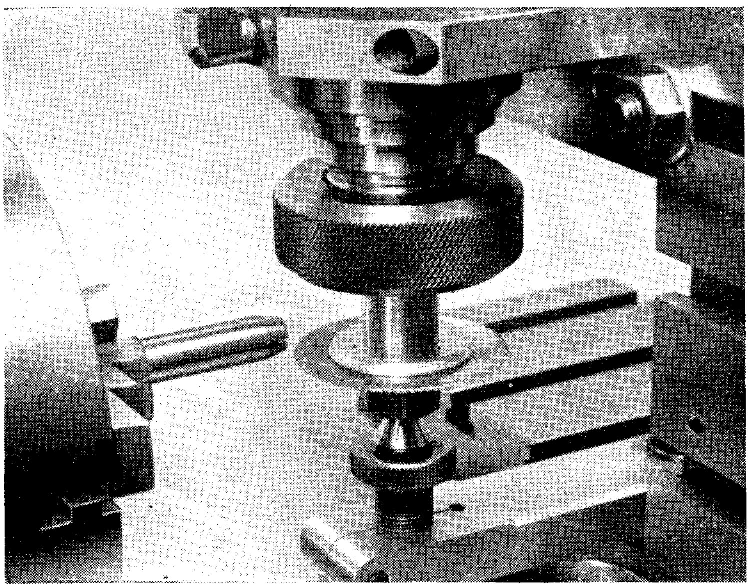


Fig. 10. Slitting the collet with a saw mounted in the lathe milling attachment

As an alternative, the magneto-type bearings with angular ball tracks are suitable for high-speed running, and these can also be fitted in pairs to take up end movement. A pair of these bearings has given trouble-free service for a period of more than twenty years, in a grinding-head similar to that specified for the twist drill grinding jig, recently described in this journal.

For those requiring further information on this subject, the design and installation of ball-bearings is dealt with from a practical point of view in *Bearings and How to Fit Them*, published by Percival Marshall & Co.

The Collet Chuck (J) and (K)

The spindle has already been bored to size for the collet. To make the collet, chuck a length of $\frac{1}{4}$ in. dia. silver-steel and drill and ream it axially to form a $\frac{1}{8}$ in. dia. bore. Next, push a piece of $\frac{1}{8}$ in. dia. silver rod into the bore and, if this runs exactly true when checked with the test indicator, the outside diameter and nose of the collet can be machined to the finished size. The work-piece is then slit in three places with a fine circular saw, as shown in Fig. 10, preparatory to parting off to length. If, however, the test-rod mentioned does not run truly, the collet should be left a corresponding amount oversize so that the part can be finished accurately by mounting it on a nutted stub-mandrel and taking a series of very light cuts with a pointed tool.

The chuck collar (*J*) is made by gripping a length of mild-steel rod in the self-centring chuck and then machining the bore and coned portion ; the thread is best screwcut to ensure accuracy.

After the outer surface has been flutted or knurled, the collar is parted off to length and finally case-hardened.

The Pulley Shroud

As shown in the photograph, a shroud is fitted over the pulley, both to protect the belt and to keep it from flying off with any sudden change of speed. This fitting was bored and milled to shape from a solid piece of duralumin, rather with a view to testing the rigidity of the milling attachment described in recent articles. It was found that a good finish, free from chatter marks, was obtained with a $\frac{1}{2}$ in. dia. end-mill, cutting for the full $\frac{3}{4}$ in. length of its flutes.

Although the fitting shown gives a workmanlike and finished appearance to the grinder, it may well be considered too elaborate and, instead, a simple sheet-metal shroud can be made to serve the same purpose.

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

REDUCING MOTOR SPEED

DEAR SIR,—I notice J.H. (Hull) has asked for information on the above, in the July 9th issue of THE MODEL ENGINEER.

May I inform him that in the "Ex-Government Stores" he may be able to obtain one of the "bomb sight computors." I purchased two at 25s. each, and in each are to be had two 25 V small motors, numerous gear wheels, including 2 to 1 reduction units, also two 40 to 1 worm drives which are about 1¼ in. cube in size. These run perfectly silently, and one of these small units would reduce his motor speed to 70 r.p.m.; it would be simple to reduce this further by some of the gears found in the "computor."

I made use of two of these in series in order to run a small musical box electrically instead of spring-driven, and it is quite a success.

These "computors" have an abundance of gearing, including bevel and worm drives, and I have found the contents most useful.

Perhaps some of the firms advertising surplus apparatus in THE MODEL ENGINEER could supply querist.

Yours faithfully,
Hastings F. K. CHALLEN

THE STANDARD RAIL GAUGE

DEAR SIR,—I was interested to read your comments in THE MODEL ENGINEER concerning the antiquity of the 4 ft. 8 in. gauge. Regarding the apparent arbitrary nature of this dimension, may I suggest that it is very close to three cubits? In the writings on the science of the Middle East there was no unanimity concerning the size of cubit, but something about 18 in. is usually quoted. Three cubits then would be 54 in., as against 56½ in. of the standard gauge.

Considering the persistence of this dimension over 3,500 years, it would seem that an argument could be put forward for regarding a cubit as one-third of 56 in. or 18 2/3 in.

The "cubit" means "an elbow" in Latin; the adoption of "three elbows" for the separation of cart wheels in prehistoric times seems a plausible explanation of the choice, being convenient in size for construction, and also the number three having magico-religious significance.

Yours faithfully,
London, E.C.1. T. L. WATKINS

DEAR SIR,—I can do something to resolve your doubts about the origin of the curious measure of 4 ft. 8½ in. for the gauge of railways in Britain (and most other places). This measure was not, as suggested in your editorial, adopted by tradition from previous wheeled traffic. My grandfather, who was Robert Stephenson's resident engineer, and was born in 1818, told me many years ago that what is now the 4 ft. 8½ in. gauge is really one of 5 ft., but in the early days of the single-flanged wheel the flange was outside the "tread" and not, as now, inside it. Consequently, the internal gauge was insignificant: what mattered was the outside gauge, and this was fixed at 5 ft. On the change to inside flanges, the rail setting was not altered, but the nominal gauge was necessarily changed to the distance apart of the rails; as these were 1¾ in. thick at the tread, what had been called 5 ft. had now to be called 4 ft. 8½ in.

Yours faithfully,
Edinburgh. G. STRUAN MARSHALL

DEAR SIR,—In recent "Smoke Rings" the interesting question of the origin of the standard rail gauge of 4 ft. 8½ in. is discussed.

We know the connection between the modern permanent way and the Roman chariots, and if we take the Mohenjo-Daro discovery as a probable pointer to the origin of the standard, it is possible to postulate certain circumstances.

Can we not assume that the distance of three cubits represented the logical wheelbase for any pair-horse vehicle, the width of which was kept to the most economical limits to allow passage through the city gates and presumably narrow roads of those far off days? To paraphrase a well-known French railway term, "Two chevaux = four hommes." In military progression or victory procession, four men abreast are about the same width as one pair-horse carriage, and until very recent times four abreast was the standard order for marching.

Another awful thought occurs. Was it not probable that slaves or prisoners of war were made to haul vehicles?

Again, "Deux chevaux, quatre hommes!"

Yours faithfully,
Luton. FRANK H. HASKELL.

DEAR SIR,—On reading your "Smoke Ring,"—"How Old Is It?" in the July 16th issue of THE MODEL ENGINEER, I thought for a few seconds, then squatted down, supporting, at arm's length sideways, a pair of imaginary cart wheels. A friend measured the centre-distance of my hand-holds; result, 4 ft. 9 in. I am about 5 ft. 11 in. tall, and may thus be a shade above average height. Perhaps two fellows supported a pair of wheels in this manner while a third cut to length and fitted the axlebeam. The preparation of chocks or supports would have been a dreadful waste of effort when *everything* had to be hewn out by hand.

Yours faithfully,
Bedford. V. S. LAYCOCK

MR. DAINTON'S "P.V. BAKER"

DEAR SIR,—May I say a few words in reply to "L.B.S.C." on "P.V. Baker with Variations," July 9th issue? In the first place, the main frames are 1/64 in. thicker than usual. The horn cheeks are milled to go through the frames, and the axle boxes do not work on the frames.

Re the reverse. I have not the slightest fear of the gears getting out of step. Due to the stiffness of the coupling bar and the way in which it is fastened to the gears. The reverse screw is worked with a balanced bar, not a wheel. I find the engine much easier to drive than with a pole reverse, and tiny notches in which the catch doesn't want to go. Half a turn or a full turn and you know just where you are. My "Baker" gear has no bent links and in several ways is easier to construct than "L.B.S.C.'s"

Yours faithfully,
Southport. G. DAINTON.

MORE UTILITY STEAM ENGINES

By Edgar T. Westbury

AFTER the parts of the crankshaft had been assembled, it was placed between centres and tested for true running. Whether by luck or good workmanship, the journals were found to be true everywhere within a limit of 0.001 in. (the test was made with the inexpensive but invaluable " Unique " test indicator), and this was considered highly satisfactory. If, however, it is found that any error exists, it will be most pronounced near the crank webs, and having found in which direction it is out, a smart tap or two with the mallet will put it right; always assuming, of course, that the boring of the webs, and other essential operations, have been carried out with due care, in the manner described. But should the holes be out of axial alignment, or their distance apart (i.e., crankpin radii) not be exactly equal, no amount of subsequent " butching and botchery " will put them right.

While the shaft is between centres, a skim should be taken over the edges of the webs and balance weights; if there is a tendency to chattering, it is possible to rig up a steady on the journal, as close as possible to the web. An alternative method, if a collet or other chuck of undisputed truth is available, is to hold it by one of the journals, with the other end supported by the back centre.

Continued from page 146, *July* 30, 1953.

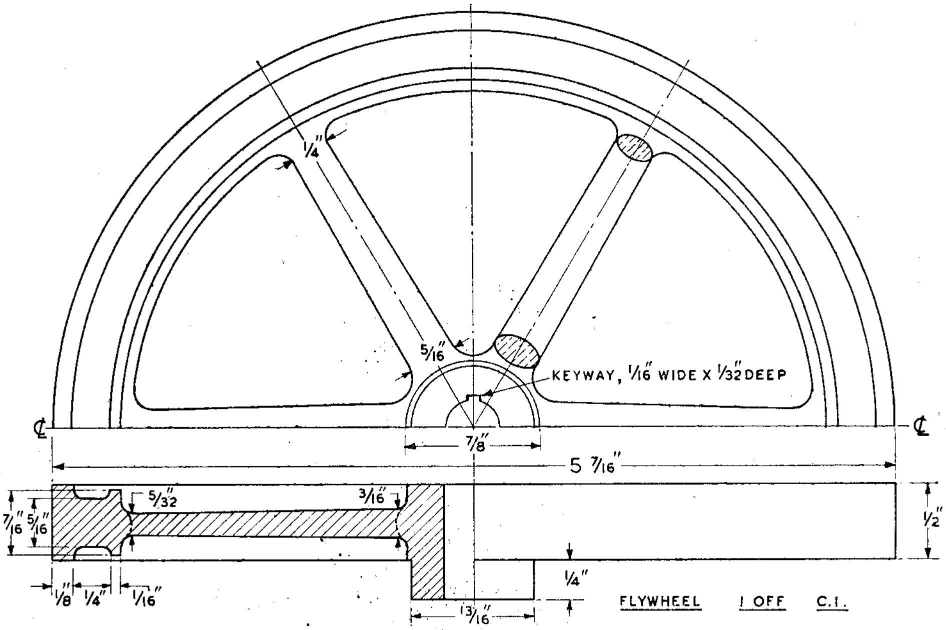
The keyways shown in the drawing were cut with the aid of a Woodruff key-seating cutter, the work being mounted on the vertical slide, using its own bearing pedestals, with the caps tightened down, as mounting jigs. To set the work square with the lathe axis, the faceplate was mounted, and the distance from its surface measured at each end of the shaft; similar measurement from the lathe bed assured that it was horizontal. It was then carefully centred relative to the cutter, by measurement (these processes have all been described in detail in THE MODEL ENGINEER) and the depth of cut measured on the index of the vertical slide. If the latter is not available, it is possible to do the job, though not so conveniently, by mounting the assembly on an angle plate on the cross slide.

It is not possible to run the keyway right up to the side of the journal bearing, when the pedestals are used for mounting, but it will be close enough for practical purposes, if the standard ½ in. diameter cutter is used. The job could be done by end-milling, which would enable the full depth of cut to be taken right up to the bearing, but this is a slower process, and does not usually produce such a clean job. The keyway is shown as located at 90 deg. to the crankpin, but its position does not matter so long as the eccentric sheave has its keyway cut so as to give the correct valve timing.

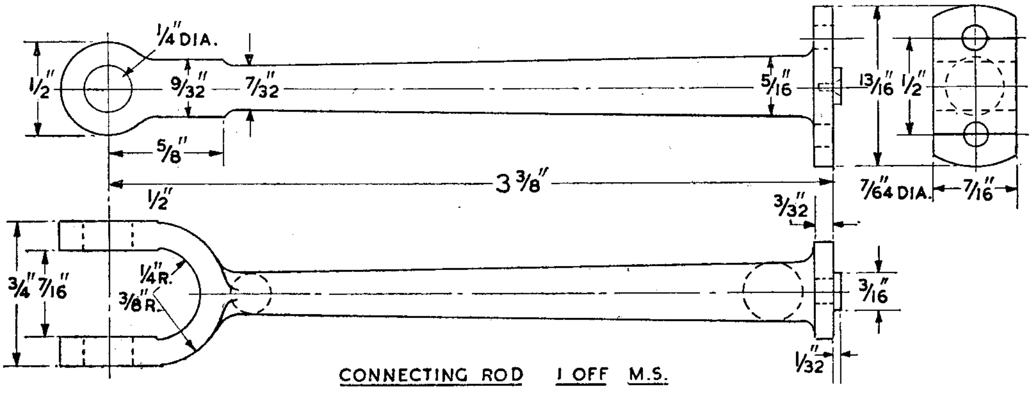
Some constructors may consider that keying the flywheel and eccentrics is an unnecessary complication; certainly it can be dispensed with, but I think most readers will agree that it produces a better job than using grub-screws, quite apart from the matter of appearance and correct practice.

Flywheel

Early rotative steam engines were usually fitted with built-up flywheels, often produced from wrought-iron forgings, with little or no machining; but as soon as good castings, and means of machining them, became available, they were extensively adopted in all but the very largest engines. As the flywheel, and in particular its machined rim, is one of the most conspicuous features in any engine, its appearance is most important; from this aspect, ferrous metals must be used, and the machin-



FLYWHEEL 1 OFF C.I.



ing and mounting of the flywheel must be carried out in such a way as to ensure true running.

It is surprising how prevalent are glaring mistakes in this respect, not to mention matters of design; and they hit one right in the eye at the first glance at a model, condemning it beyond redemption despite any merits which may be found in other components. Very commonly, the shape or proportions of the flywheel rim and spokes are all wrong; in a set of castings for a certain (alleged) mill engine of commercial design, the spokes were found to be of rectangular section, and about one and a half times as large in cross-section as the rim! While it is not possible to state dogmatically that no full-size engine ever had such a flywheel, it is rather unlikely, as the old-time engineers had a keen eye for design; and in any case, fastidious model engineers do not aim to reproduce the "horrible examples!" In the present case, the proportions of the flywheel can be guaranteed fairly accurate, as careful measurements were taken after the casting had been broken up, affording useful evidence in the matter of cross-sections of rim and spokes. Fortunately, in this instance, I am able to steer clear of the "curved spoke" controversey!

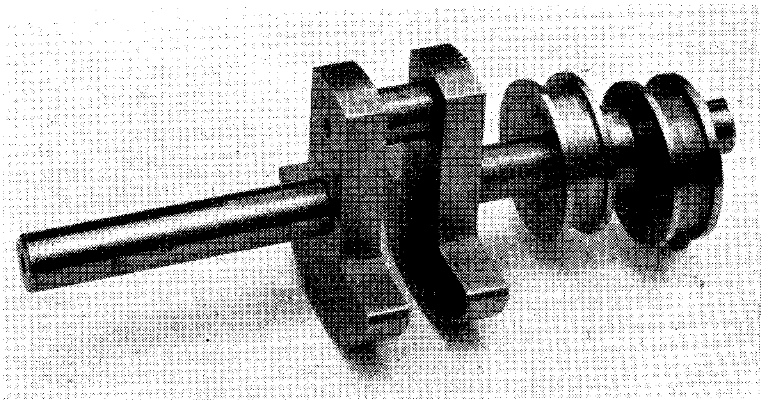
Machining Method

For machining the flywheel casting the only really satisfactory method is to mount it on the faceplate. In order to ensure resilience, and also to avoid risk of running the tool into the faceplate, I first made a hardwood backing, which was held by wood screws from the back for skimming up parallel on both faces, after which bolt holes were drilled, and the casting was then secured to this backing by means of two-bolts and plates across the spokes. In order to avoid risk of cracking the latter by undue pressure of the clamping plates, those which took the stress were backed up with metal packing-pieces, and discretion used in tightening the bolts.

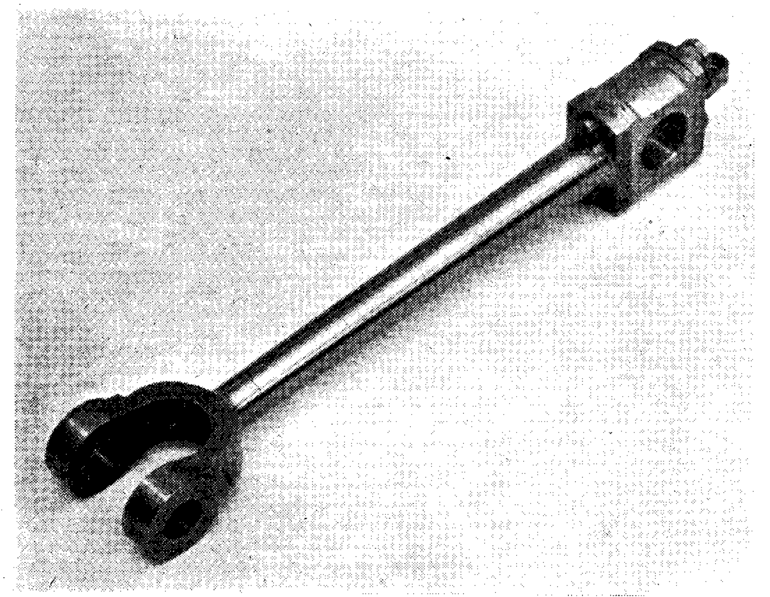
In setting up any casting which is not to be machined over all its surfaces, it is a sound rule to concentrate on getting the parts which do not have to be machined as true as possible, so that in the completed job there will be no serious discrepancies in uniformity or symmetry. A wheel, even if it runs true on the outside of the rim, will look pretty awful if the inside rim or outside of the hub, are wobbling. This is a matter often neglected, not only in stationary engines, but also in mobile models, where it is even more conspicuous.

The flywheel is first set up with the outer face against the wood backing, and turned over the face and projecting diameter of the hub, and the side and outer diameter of the rim. The latter will have to be turned, at least for the preliminary roughing cuts, at the slowest back-gear speed, and unless one has a carbide tipped tool, it is probable that tool wear will be heavy until the hard skin of the metal has been removed. It will be found easier to turn the annular groove in the rim from the solid than to clean up a groove that has been cast more or less to the correct shape. To ensure maximum steadiness, it is a good idea to apply end pressure to the work by means of the back centre or drill pad. The rim may be finished to size with a keen tool, and the lathe speeded up for centring, drilling, boring and reaming the hub, at the same setting.

The casting may now be reversed for machining the other side of the hub boss and rim. It will be found necessary to recess the wood backing to take the inner projection of the hub, and if this is done carefully, to a snug fit for the latter, it will centre the wheel accurately. As a still further assurance of true running, a centred plug may be made to



The built-up crankshaft, with valve and pump eccentrics in position



The complete connecting-rod with big-end brasses attached

fit the bore, and the back centre brought up to act as a support. Check the truth of the outside of the rim before proceeding to turn the side and the annular groove, to match the other side of the flywheel.

With due care, the flywheel should run hair-true on its shaft after machining in this way. One often sees at exhibitions engines running on compressed air, with the flywheels looking as if they were designed to serve as swashplates or face cams, and one wonders how the constructors managed to achieve such an intriguing result! It may be observed that the old-timers managed to get flywheels to run true, even though the bores were often rough-cast, and had to be staked to the equally rough shafts.

The internal keyway in the flywheel was cut in the manner which has often been described by myself and other contributors; namely, by using a slotting tool held endwise in the toolpost, and racked backwards and forwards, taking light shaving cuts. The tool should be made exactly the same width as the cutter used for the shaft, with back clearance, and mounted exactly at centre height; I ensure this by mounting it permanently in a block of steel, drilled from the chuck to take a round silver-steel cutter. For this operation, the work may be held in the three-jaw chuck by the inner projection of the hub.

If you decide not to go to the trouble of keying the flywheel, don't, please DON'T, fix it to the shaft with an ugly great screw projecting from the hub; at least have some consideration for the feelings of sensitive observers by sinking it as unobtrusively as possible, either flush or below the hub surface. As one of my fellow-judges at an exhibition once remarked—" I do wish these fellows would give their grub-screws a decent Christian burial ! "

Connecting-Rod

The type of rod used in this engine is very commonly seen in both stationary and marine practice; in full-size engines, it is usually made from a forging, and early in my engineering career, I became acquainted with the practical problems of machining these rods. In those days, turners took a great pride in producing the highest possible tool finish on the curved surfaces. In the case of a model, forgings are out of the question unless one is a skilled blacksmith; castings, in malleable iron or gunmetal, are often used, but the method I consider most likely to produce good results is to machine the rod from solid stuff. This entails a little scheming, and the machining away of quite a good deal of metal; but it is one of the most interesting jobs in the entire engine construction.

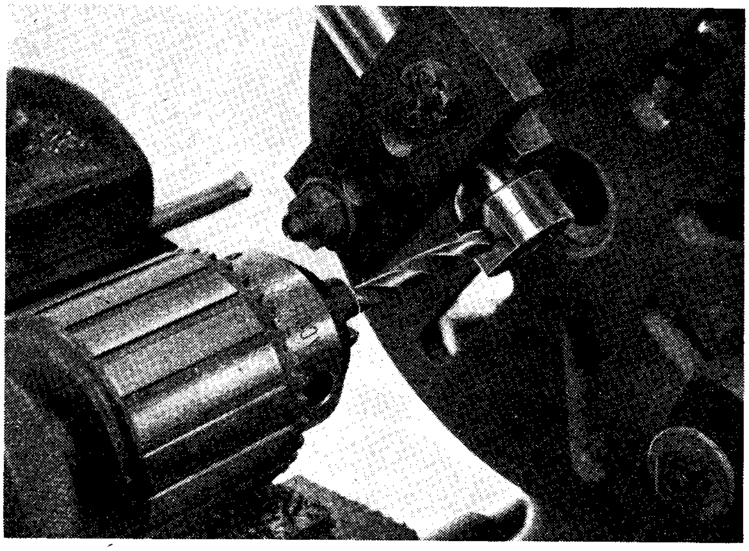
This rod started as a piece of mild-steel bar, $\frac{7}{8}$ in. diameter by approximately 4 in. long, which was first faced and centred at both ends, and then turned between centres to slightly over $\frac{13}{16}$ in. diameter, exactly parallel, for 3 in. of its length. It was then reversed end for end, and necked down to about $\frac{1}{4}$ in. diameter at 1 in. from the end, using a round-nosed tool, after which the contour of the outside of the fork was turned, using hand tools to finish this as highly as possible, with well-swept curves, without touching the first $\frac{1}{2}$ in. of length. Liberal application of soluble cutting compound, or "suds," helped greatly in obtaining the required finish. A point tool was then used to locate the position of the wrist-pin centre at $\frac{1}{4}$ in. from the end.

Forming the Fork

At this point, straightforward turning operations were suspended, and the operation of forming the fork end was tackled. The rod was set up across the faceplate, using a vee packing block as a means of keeping it truly parallel (here will be seen the reason for turning the main length of the rod dead parallel, and leaving it as large as possible in diameter), and set up so as to centre the marked location for the wrist-pin. In order to ensure that the hole for this goes exactly through the centre of the diameter, take a light facing cut over the (as yet) unmachined portion; this will provide a "witness," which should be centre-punched exactly in the centre, and $\frac{1}{4}$ in. from the end face of the rod. With due care to avoid rotating the work in its vee block, the dot is then centred, after which the surface can be machined back $\frac{1}{16}$ in. (measure from the back face), centre-drilled, pilot-drilled, bored and reamed $\frac{1}{4}$ in. for the wrist-pin. A witness cut can also be taken to outline the outside of the eye, as far back as the rest of the fork will allow; but avoid cutting into it.

To face the other side of the eye, the rod may be turned round in the vee block, and a short $\frac{1}{4}$ in. mandrel pushed into the bore to assist in setting up; if this is truly centred at the ends, it may be possible, by using the back centre in conjunction with a short live centre, to locate the work positively and avoid tedious setting up. Next, the job was held by the parallel end in the chuck and drilled 27/64 in. diameter to a depth of $\frac{5}{8}$ in. (to the drill point) to remove a good deal of unwanted metal.

It is now necessary to form the inside of the fork, which can be done



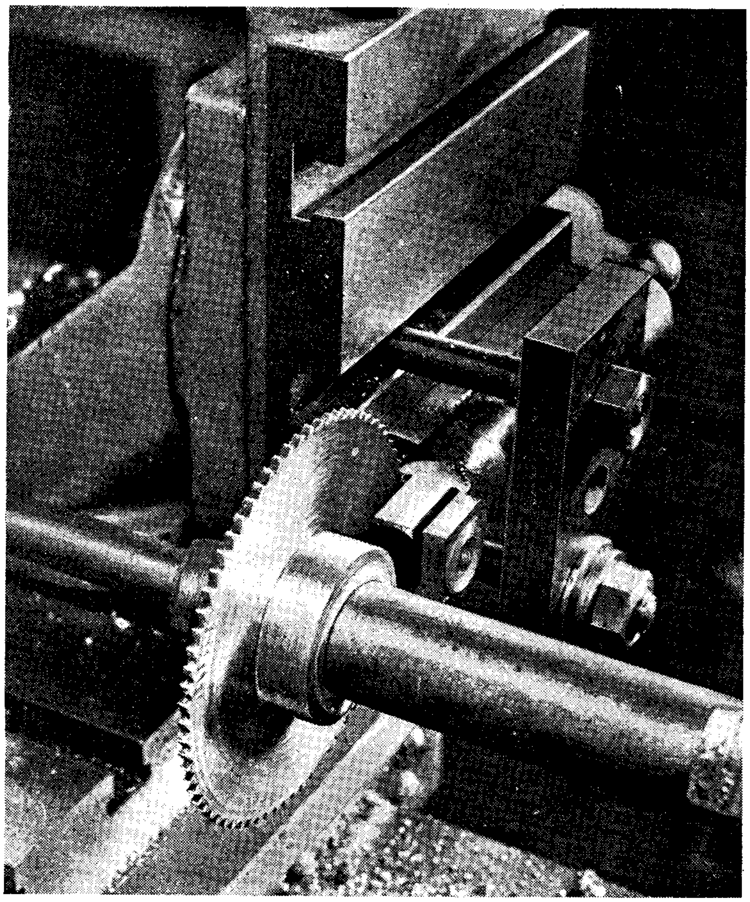
Connecting-rod clamped in vee packing block on faceplate for facing and drilling the little-end eye

quite satisfactorily by sawing and filing if desired, but machining methods make accuracy easier and more positive. I used a circular saw on a mandrel between centres to make what a surgeon would call the "crucial incisions," the rod being held horizontally on the vertical slide as shown in the photograph. Before the sawing operation, the $\frac{3}{4}$ in. mandrel was pushed through the hole, and checked for height at each end to ensure that the cuts would be exactly square with the hole. It is, however, advisable to make the gap slightly undersize in width, and clean up the inner surfaces finally with a piloted cutter such as used for the gudgeon-pin bosses in pistons. The tongues of metal left between the sawcuts can be removed by drilling cross holes, and the fork may be finished, both in the gap and over the outside contour, by filing or machining as desired. I did the job mainly by milling, first with the rod still in the sawing position, and afterwards by rotating it at right-angles to deal with the semi-circular inside surface.

After completing the work on the fork end of the rod, a block of metal should be carefully fitted in the gap and temporarily secured in place, either by bolting through the wrist-pin holes, or by soft-soldering. The object of this is to take a centre to enable subsequent operations to be carried out; the rod may be held in the chuck, with the block in place, to enable this centre to be drilled. It is now possible to remount the rod between centres and carry out the remaining turning operations, including the front, back and outer surfaces of the foot, the locating spigot on the end (leave the fitting of this till the crankhead brasses are made) and the taper shank. The length of the rod, from the wrist-pin centre to the outer face of the foot, should be checked, though slight errors in this dimension can be compensated when fitting the piston-rod.

The taper on the rod is quite small, and is most readily carried out by setting over the tailstock, if means for doing so are available; the amount is not critical, but will be about 0.055 in. in the full length of the rod. With the fork at the driving end, the set-over will be

(*Continued on page* 204)



The connecting-rod mounted on the vertical slide for sawing out fork end

LAYOUT OF STEPHENSON LINK-MOTION

Notes on planning the Valve-gear for a $\frac{3}{4}$-in. scale G.W.R. Bogie Single Locomotive

By D. G. Webster

DIAGRAMS (4 and 5) show the effect of linking up when a valve is set to Diagram (3) at $\frac{1}{2}$ and $\frac{1}{4}$ the slot length from mid-position. It will be seen how everything is advanced, and while in full gear the lead was nil, in Diagram (5) the lead is quite appreciable.

Diagrams (4 and 5) are obtained by drawing an equivalent diagram, as shown in Diagram (6), using Macfarlane Gray's contruction. This formula proves that if the centre of the die-block lies on any point other than in line with the longitudinal centre-line of the eccentric-rod, the centre of the equivalent eccentric must lie on a radius (R) which passes through the fore and back eccentric centres in full gear and the centre of the equivalent eccentric in mid-gear, and the radius (R) is equal to :—

Concluded from page 167, August 6, 1953

$$\frac{\textit{Distance between eccentric centres} \times \textit{Length from eccentric centre to link centre}}{2 \times \textit{Distance between link eccentric rod pin centres}}$$

While this formula is not absolutely correct, it is near enough for all practical purposes.

The construction is as follows, and applies to a launch type link motion : Draw a circle *AB* representing to some scale the full-gear travel and circle representing the lap. As the lead is nil, *B* represents the steam admission, *F* cut-off, *G* release and *D* compression. *DOB* is also the angle of advance and *DE* must be the distance between the two eccentric centres. *DO* also represents the eccentric throw which equals $\frac{1}{2}$ travel. *DE* can be measured and as the other measurements are known the radius (R) for the equivalent eccentric can be found and drawn on a projection of *OR* for open rods and on *OQ* for crossed rods. *DE* also represents to another scale the distance between the link eccentric-rod pin holes. Points *L* and *T* represent the position of the die-block pin centre when linked up from *D* to $\frac{1}{2}$ and $\frac{1}{4}$ the distance from mid-gear, and *OM* and *OU* are the respective equivalent eccentric throws equal to $\frac{1}{2}$ travel, while *MOB* and *UOB* are the respective angles of advance for these positions.

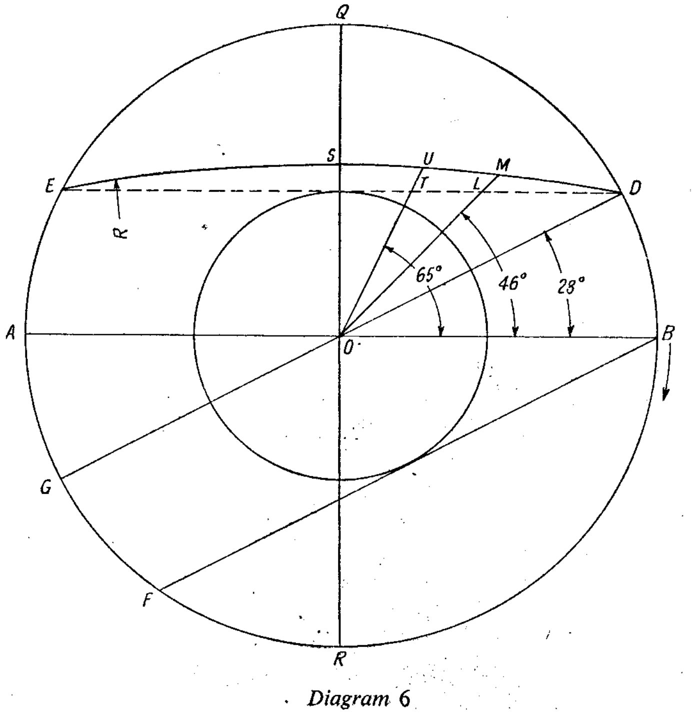


Diagram 6

Thus, for each case, we now have the valve travel, the angle of advance and the lap, which remains constant, and the valve diagrams can be constructed in the same way as the full-gear one. As a matter of interest, the tables on the next page show the results taken from Diagrams (3 and 5) compared with a set of figures published for a G.W.R. "Saint" class, 4-6-0, two-cylinder engine.

The similarity is rather interesting, especially as the "Saint" has eccentric-rods 4 ft. 3 in. long, and my version of the "Dean" a scale equivalent length of 5 ft. 4 in.

It is a very good example of the effect on lead of the initial eccentric setting, also the effect eccentric-rod length and hence link radius has on the valve events when linked up with due regard to lap and port openings.

When Mr. Churchward designed the "Saints" he set out to produce an engine capable of exerting a 2-ton drawbar pull at 70 m.p.h., using the least possible coal and water. This meant that the maximum steam pressure had to be available in the valve-chest, and the back pressure of the exhaust had to be as low as possible consistent with its being able to cause enough draught for the fire to produce the required amount of steam.

At the same time, this valve-gear had to fit other engines with the necessary modifications being made on the valve-rod length connecting the link to the inner pendulum arm. I am talking of outside cylinder engines fitted with inside Stephenson link motion.

Having decided on the valve events necessary to give the requirements at high speed it was also

necessary to provide an even crank torque with high power for starting and low speeds, and to get a late enough cut-off to do this, the link radius had to be made small, meaning short eccentric-rods. This is an advantage as far as weight, strength and other such considerations are concerned ; but it does, however, entail having negative lead in full gear. Since this position will only be used when starting, and not always then, any disadvantages are of small moment.

Cut-off Delay

I am aware that in the United States some of the engines have a cut-off of 50 per cent. in *full gear*, but these engines are also fitted with an auxiliary arrangement that can delay the cut-off up to 85 to 90 per cent. for starting, or when operating conditions require it. The *Locomotive Cyclopaedia* explains the arrangement in detail and if any reader has a volume of this book, I for one would like to know just how it is done.

To return again to Realeaux diagrams, if only some of the valve event information is known, the remainder can be found by simple graphical construction.

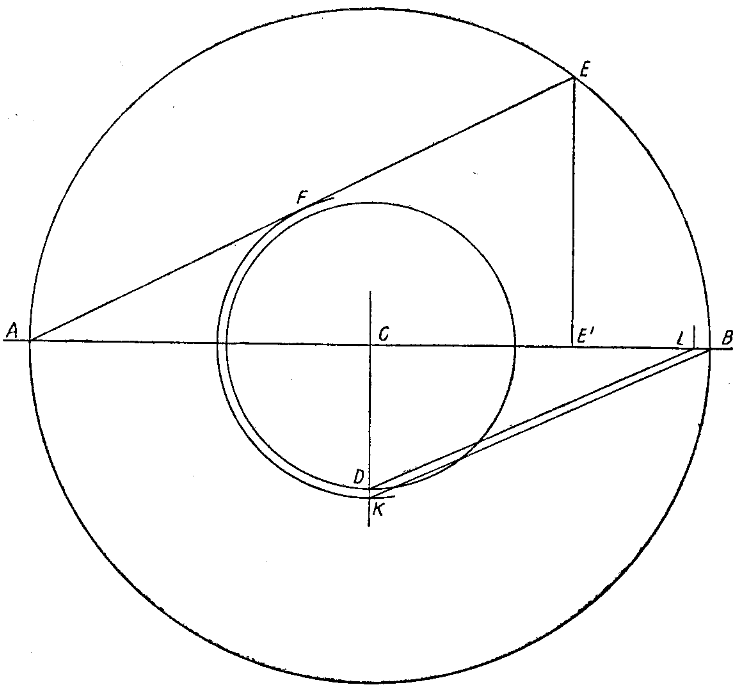


Diagram 7

Diagram (7) shows the construction. Given lap, lead and percentage cut-off, draw any circle *AB*. From centre *C* draw a circle *CD* of radius equal to the given lap and if there is any lead, either positive or negative, another circle at *A* of radius equal to that lead. Mark off *AE'*, equal to the given cut-off, on *AB* and erect a perpendicular to *E*. If the lead is nil, draw a line through *E* to *A*. Draw a radius *CF* to touch *AE* and continue *CF* to *K*. *CF* is the lap of the trial circle *AB*. Join *KB* and draw *DL* parallel to *KB*. *CL* is equal to half the required travel or *CK* : *CD* : : *CB* : *CL*.

If the lead is positive, the construction is slightly different. Draw internal tangents to the lap and lead circles to find the intersection point *O* on *AC*. Join *OE* then continue as before making *CF* touch *OE*.

For negative lead, *AE* is drawn from *E* as an external tangent to the *lead* circle, after which the construction is the same as before.

Diagram (8). Given cut-off, maximum port opening and angle of lead, draw any circle *AB*. Draw *ACD* equal to the angle of lead. Mark *AE'* equal to the cut-off on *AB* and erect a perpendicular to *E*. From *C* draw a circle of radius *CF* equal to the given port opening. Join *ED* and the port opening for the trial circle is *GH*. Mark off *CK* equal to *GH*, and draw *FL* parallel to *KB*. *CL* is the required ½ travel.

Diagram (9). Given port opening, lead and cut-off, draw any circle *AB*. From *C* with radius *CK* equal to the port opening draw a circle and another at *A* with radius equal to the lead. Draw external tangents to these circles meeting at *O*. From *O* with radius *OA* describe a circle. Mark off *AE'* equal to the cut-off on *AB* and erect a perpendicular to *E*. Draw a tangent *EF* to the outside circle meeting it at *F*. Then *GH* is the port opening of the trial circle

G.W.R. 18″ x 30″ CYLINDERS (MEAN OF FRONT AND BACK PORTS) PISTON VALVE

Notch	Steam Lap	Lead	Exhaust Clearance	Cut Off	Steam Port Opening	Exhaust Port Opening	Exhaust Opens	Exhaust Closes	Valve Travel
Full ...	1.625″	−0.15″	Nil	77.5%	1.5″	3.12″	94%	94%	6.25″
Fast ...	1.625″	+0.12″	Nil	28.8%	0.33″	1.95″	74.5%	74.5%	3.91″

3/4 " DEAN " SINGLE SIZES SCALED UP TO FULL SIZE SLIDE-VALVE

Notch	Steam Lap	Lead	Exhaust Clearance	Cut Off	Steam Port Opening	Exhaust Port Opening	Exhaust Opens	Exhaust Closes	Valve Travel
Full ...	1.5″	Nil	Nil	78.5%	1.75″	3.5″	93.8%	93.8%	6.5″
Fast ...	1.5″	+.25″	Nil	29.5%	0.4375″	3.5″	71.25%	71.25%	3.9″

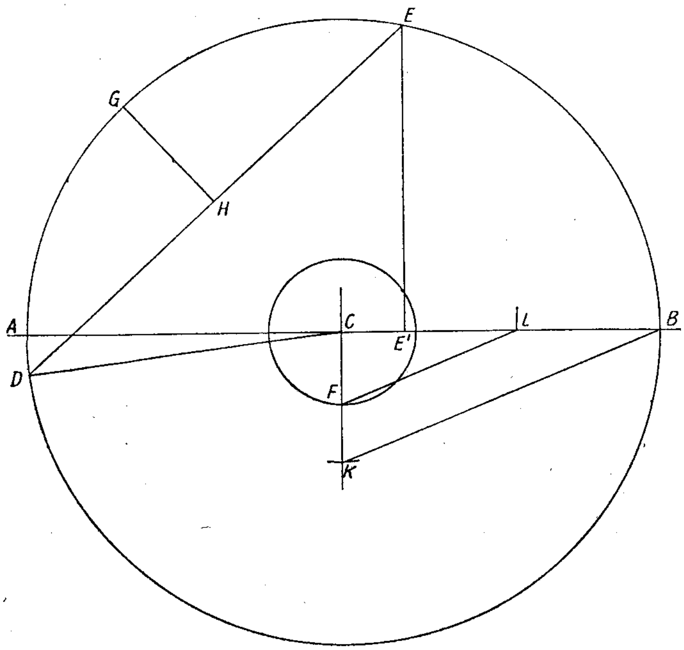


Diagram 8

AB. Mark down *CD* equal to *GH.* Join *DB* and draw *KL* parallel to *DB.* *CL* is the required ½ travel.

It sometimes happens that one wants to build a model of a certain engine, and the valve travel, etc., cannot be ascertained. Most official g.a. drawings show on them a fairly accurate layout of the valve-gear and the ports with just a few of the dimensions. A reasonably accurate idea of the valve events can be obtained by measuring the drawing where dimensions are not given, by constructing the equivalent eccentric diagram, in the case of locomotive-type links, and then the valve diagrams ; or the valve diagrams direct in the case of a launch-type link if the drawing shows the motion in full gear. It will normally be drawn in mid-gear, with the crank on half stroke. This does not matter, as the eccentric centres will be marked and the angle of advance can be measured ; also any offset to the die-block pin centre in full gear.

Diagram (10) is a line drawing of the locomotive-link gear fitted to the " Dean," giving all the necessary particulars to construct the diagrams. These particulars were either measured or given on the official general arrangement, and the drawing, as is normal for railway general arrangements, is 1½ in. = 1 ft. scale. It was drawn in 1898 and is a masterpiece of the old fine-line technique. It was quite easy to measure and, allowing for inaccuracies on the part of the draughtsman and myself, the resulting dimensions will be well within ⅛ in. of actual sizes. The sizes given on the drawing were : Ports, 2 in. wide ; Port bars, 1 in. wide ; Exhaust port, 3¼ in. wide ; Eccentric rod length, 6 ft. 1 in. It was quite easy to measure the remainder with a scale rule. I also found, quite by accident, the slide valve lap 1⅛ in. Previously, I had intended to assume a lap and I am assuming there was no exhaust clearance.

It will be observed in the line drawing of the valve-gear that, when in full gear, the eccentric-rod is offset to the die-block pin 4½ in. Measuring the drawing I found that the nearest die-block pin centre could come to the eccentric-rod centre was 4 in. and the additional ½ in. is to allow for link slip.

I now had all the necessary dimensions to construct the equivalent eccentric diagrams, as follows :—

Fig. (11). Draw a circle *AB* of radius equal to the measured eccentric throw. *DCB* equals the angle of advance, and *CM* is the measured distance the eccentric centres lie from the axle centre, i.e. the linear advance. *DE* is the measured distance between the fore and back eccentric centres.

The equivalent eccentric radius

$$R = \frac{73 \text{ in.} \times 5.9375 \text{ in.}}{2 \times 17.75 \text{ in.}} = 12.21 \text{ in.}$$

As the eccentric-rods are open *ELD* is struck from an extension of

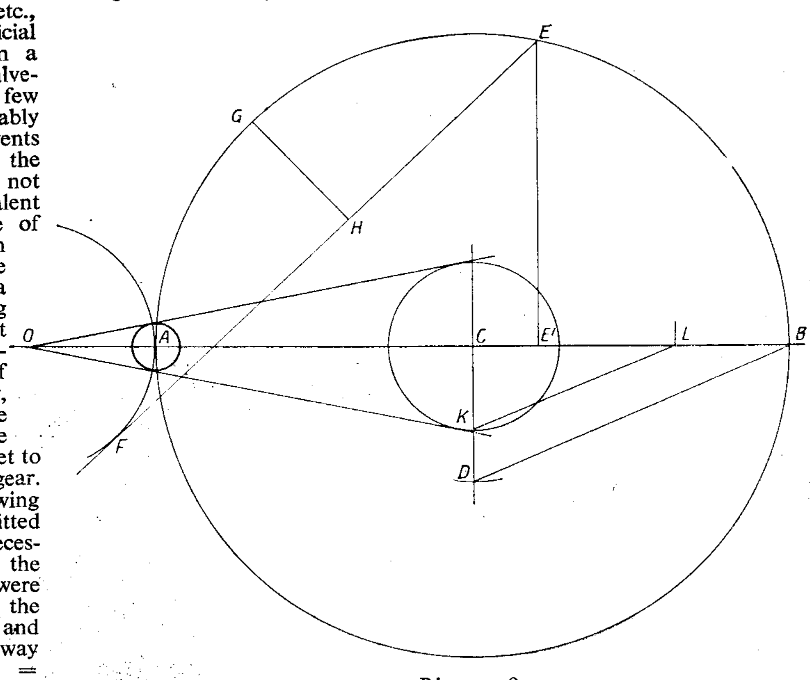


Diagram 9

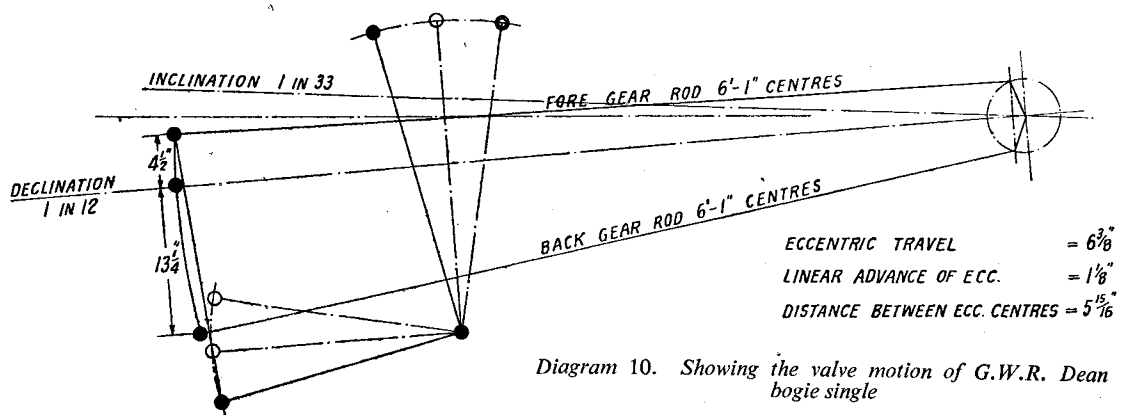


Diagram 10. *Showing the valve motion of G.W.R. Dean bogie single*

CT. ED also equals to another scale the distance between the eccentric-rod pin centres of the link. *FD* is the scale distance of the offset from the fore gear eccentric-rod pin centre to the die-block pin centre and is found by

$$\frac{4.5 \text{ in.} = 5.9375 \text{ in.}}{17.75 \text{ in.}} = 1.505 \text{ in.}$$

CH equals the equivalent half-travel at this position and *HCB* equals the angle of advance.

We now have the valve travel, the angle of advance, the lap and assuming there is no exhaust clearance it is an easy matter to construct the valve diagrams. Figs. (12 and 13) show the diagrams obtained for full gear and when linked up to ⅞ in. from mid-gear, and the events are given in the table on next page.

These results show a valve setting certainly above the average for the period and that Swindon in 1890 were well established along lines that are comparable to modern ideas as far as valve events and front end design are concerned.

The first of the singles built as "bogie" singles, No. 3031, *Achilles*, came out in March, 1894, and that they were very efficient engines is shown by the coal figure of 31 lb. per mile, and this with a boiler pressure of only 165 lb. per sq. in. and saturated steam. Also, they could move with a train within their power limits, as shown by the classic run of No. 3065, *Duke of Connaught*, when she took over from *City of Truro* at Bristol the Ocean Mail, and with a load of 120 tons despite several speed slacks for various reasons ran the 118¾ miles to Paddington in 99¾ min. with the worst slack of all to a walking pace just the London side of Swindon. From this slack 3065 took 59¼ min.

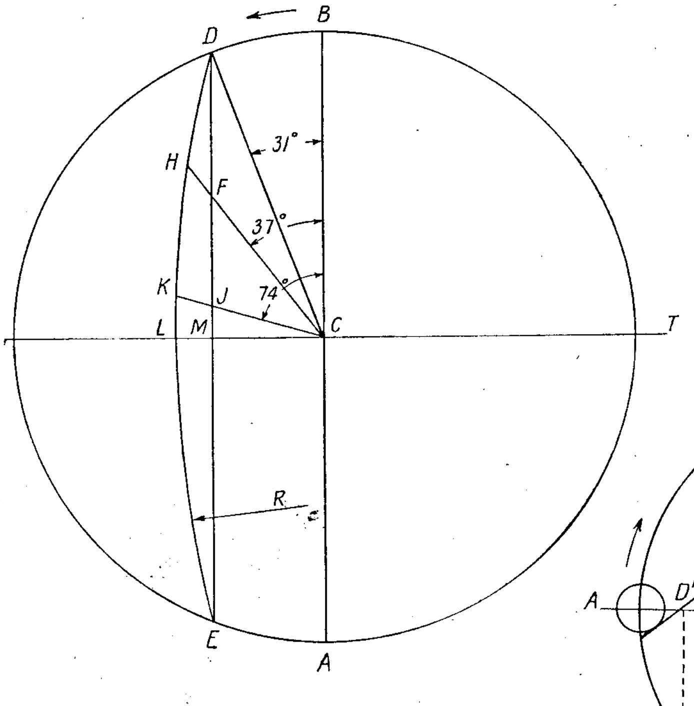
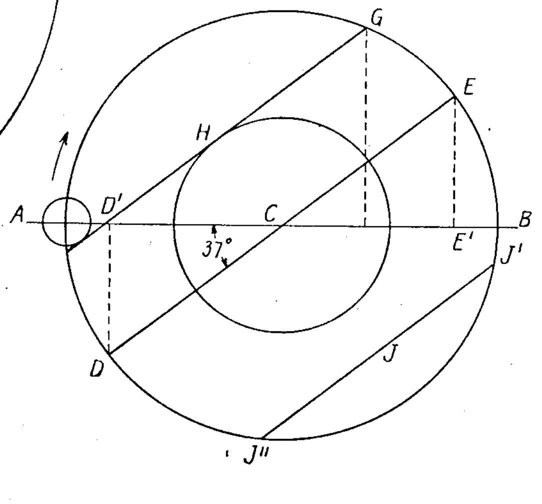


Diagram 11



Right—Diagram 12

MEAN OF VALVE EVENTS. G.W.R. "DEAN" BOGIE SINGLE

Notch	Steam Lap	Lead	Exhaust Clearance	Cut Off	Steam Port Opening	Exhaust Port Opening	Exhaust Opens	Exhaust Closes	Valve Travel
Full ...	1.125″	+0.25″	Assumed Nil	70%	1.125″	3.25″	90%	90%	4.5″
Die Block ⅞″ from Midgear	1.125″	+0.343″	Assumed Nil	24.5%	0.406″	3.0625″ Max.	63.25%	63.25%	3.0625″

for the 77 miles to London, an *average* speed of almost exactly 80 m.p.h. from Shrivenham.

At the same time as the singles were being built, four 2-4-0s built between 1886 and 1888 were taken in hand and rebuilt as 4-4-0s. They had 20 in. × 26 in. cylinders and 7 ft. 1½ in. drivers. Apart from this, they were almost identical with the singles, having the same bogie, boiler and valve-gear.

Not So Fast

They must have been rebuilt so as to compare with the singles, and it is interesting that, although good engines, I understand they were never as fast as the singles and

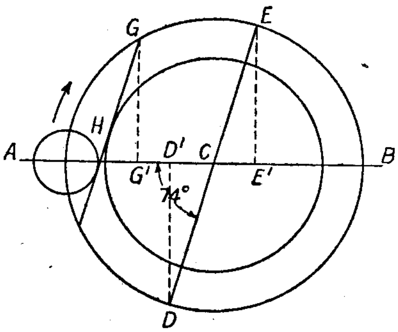


Diagram 13

always seemed choked at high speed. I suggest this may have been due to the smaller driving wheels and longer piston stroke, increasing the piston speed, steam velocities, compression, back pressure, etc., sufficient to have an effect on the exhaust freedom. This shows the genius of Mr. Dean in designing valve motion, etc., to the maximum limits for the singles.

This genius was again demonstrated when shortly after nationalisation a light 2-6-0 tender engine the prototype on which the design of the standard Class "2" mixed traffic engines was to be based, was sent to Swindon for test.

As these Class "2" engines will replace the "2301" Dean 0-6-0 goods, one of the latter which was due to leave the shops after overhaul was put on to run turn for turn on local goods traffic. It wasn't very long before the drivers were asserting that, for the same job, the Dean 0-6-0 was the better engine as far as coal and water consumption were concerned, and after a locomotive inspector had checked this the Swindon "back room" boys got down to it properly. Tests, both on the road and test bed, proved conclusively that the "Dean" was superior over most of its operating range. The results were sent back to the design office concerned together with some suggested fairly slight modification to the front end design. It was then that the 2-6-0 appeared in its true light as one of the most efficient engines in the country. The story does not end there, however, as although Swindon knew the Dean 0-6-0s were good these results caused some surprise.

It is here that modern research comes into play with the vast amount of data and methods of application behind it. Investigation was made to find out why an engine designed in 1883, so well that the whole of the motion and front end design have *never been altered*, should prove so superior to its modern replacement. Just what was discovered is not yet known outside of official circles; but one thing is certain; if Mr. Churchward is rightly called the "Keystone of Modern British Locomotive Development" as far as cylinder and front end design is concerned, Mr. Dean must be called the "stone" from which the "keystone" was cut.

MORE UTILITY STEAM ENGINES

(*Continued from page* 199)

away from the operator. Alternatively, the swivelling top slide may be used, the only difference being that in this case one cannot use the self-act, and it may not be so easy to get a really good finish. The latter is important, but it is no serious crime to use a smooth file, followed by emery cloth, so long as the desired result is achieved.

In many engines the connecting-rods are not made with a straight taper, but are slightly bulged or "fish-bellied" in the centre. There was no evidence of this, however, in the prototype on which this model was based, but I do not think there would be any objection to introduce it at the discretion of the constructor; it is generally considered to enhance the appearance of the rod if carefully carried out.

It is now necessary to devote attention to the foot of the rod, the first operation on this part being the cutting away at the sides to enable it to pass between the crank webs. A very important point is that it should be cut square with the axis of the wrist-pin, and there are several possible methods of marking-out and checking to ensure this. One of the simplest is to fit the ½ in. mandrel to the wrist-pin hole, with the projecting ends resting in matched vee blocks, on a surface plate, and using a try-square to mark out the foot. I achieved the same result by setting the mandrel between centres, with the faceplate fitted to the lathe mandrel, and using a scribing block against the faceplate.

The sides of the feet may be milled or filed away, and should be symmetrical, but preferably not finished to final width until after the brasses are fitted.

(*To be continued*)